The Foundry Trade Journal

AND

PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 7. MARCH, 1905. No. 39.

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To place the "Journal" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of 5/- per annum, such order to be countersigned by the superintendent or foreman of the shop as a guarantee of good faith.

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All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

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AGENTS.

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BRITISH FOUNDRYMEN'S ASSOCIATION.

As no doubt the members of the above are aware by now, the Council has resolved to recognise the FOUNDRY TRADE JOURNAL as their official organ. The Council have been considering from the first ways and means of advancing the usefulness of the Association. They recognise that the one meeting a year will fall far short of accomplishing the many objects they have in view, both from an educational and social standpoint. They have, therefore, taken the above step as one which they think is in the right direction to accomplish a little towards their aim, and have moreover, elected a Literary Committee, whose duty it will be to see that there appears each month an article in this magazine under the Association's heading bearing on matters relating to the Association in particular or the trade in general. By this means it is hoped to get more in touch with the members, and they will be pleased to see, either by direct communication with the Secretary or by letters in this JOURNAL, that a lively interest is being taken in anything that may be put forward in these articles, and thus enable all to get the full benefit from them.

Up to the present the foundry trade in England has, unfortunately, been such an exclusive one; every foundry, as it were, constituting a little world of its own without intercourse with any other, that one feels it will take a long time to break down this state of affairs, but it is hoped that this monthly touch with actual members of the trade will do something to broaden out good relationship one with another, which, up to now, has seemed to exist only in a latent form.

Another way in which the Council hope to further this aim is by dividing the United Kingdom into districts, and endeavouring to band the members therein into sub-Associations with a secretary to each.

When this is accomplished it is felt there

will be no difficulty in arranging for lectures to be given in the various centres at intervals throughout the year, and arrangements made for visiting works, etc.

It is felt that this will have a most beneficial effect on the members generally.

The Secretary is working well in this direction, but it will undoubtedly be some time before it can become an accomplished fact. In the meantime, however, much can be done by emulating the example of our President, as set forth in the notice in January number, *i.e.*, by our members who are about to read papers on foundry matters before engineering societies or at technical schools making an effort to get the committee to give their sanction for the members of the British Foundrymen's Association to attend. If our lecturing members will do this, and have a notice sent to the Secretary, he will see that a notice is inserted in this JOURNAL, much good will be done, and, as far as my experience goes (which in these matters is a rather wide one), I am sure there will be no difficulty whatever experienced in such an arrangement being brought about, for there are now Associations existing where even the members of one are allowed to attend free the lectures of the other, and, I think, there are none who are not glad to welcome visitors to their lectures.

F. J. C.

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J. T. Milton, Esq., Chief Engineer Surveyor to "Lloyd's Register," will lecture before the Rugby Engineering Society, at the Benn Buildings, High Street, Rugby, on the evenings of March 10 and 24, 1905. Subject:—"The Minute Structure of Metals." The chair will be taken at 8 o'clock by J. S. Conover, Esq. Members of the British Foundrymen's Association are cordially invited to attend, and will be admitted by presenting their card of membership.

F. W. FINCH,
Hon. Secretary.
British Foundrymen's Association.

—o—

A RECEIVER and manager has been appointed in connection with the affairs of J. & S. Roberts, Limited, the well-known ironmasters. In the application before the Court it was stated that contracts were pending to the value of about £16,000, and on these a considerable profit might be expected if funds could be provided to carry on the business for a time. The judge gave leave to raise £500.

STUCCO WORK IN PATTERN-MAKING.

PATTERN-MAKING may be said to be divided into two sections, viz., engineering and foundry. The class of work performed under these respective heads, although known by the same name "pattern-making," is entirely of a different nature; in this respect, that the engineer pattern-maker, is never called to work with any other material than wood, whereas his brother in the foundry, where a general trade is carried on, is called upon to use several materials with which to make patterns, and among these stucco may be said to be by no means the least prominent.

Lead is another material which is largely used in some foundries, but it is not our intention in this article to deal with this form of pattern-making any further than to merely mention it.

There are several classes of the foundry trade to which the use of stucco can be more readily adapted than others, but it is also the case that there are many branches of the trade where most expensive patterns are made in wood, where stucco might be used to advantage.

In these days of keen prices every item in the production of castings must be cut down to a minimum, and a most important item when only a few castings are required is the cost of the pattern. It is often the case that the foundry which can produce the castings with the least pattern expense is the one which secures the order; every hour expended on the pattern adds to the price of each casting, and when only a few castings are wanted this has a very serious effect. It therefore behoves every foundryman to see that his patterns are made in the most expeditious manner and with the cheapest material. The class of trade to which stucco may be said to be most suitable is that known as the "Rain Water," or "Hollow ware" trade, and the reason why this trade is chiefly confined to Scotland is that the patterns for the various connections are produced at the least possible cost by the free use of stucco; in fact, the working of this material in some of our Scotch foundries is reduced to a fine art.

The value of stucco as a material with which to make patterns cannot be overestimated; its plastic nature renders it suitable to be shaped practically into any form, and its readiness to set into a hard substance enhances its value. The usual method, when a number of castings are required, is to make an iron pattern from

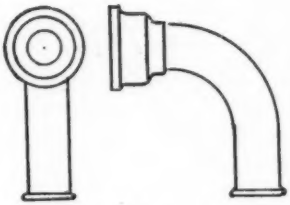


FIG. 1

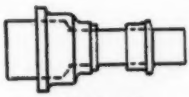


FIG. 2

FIG. 3

FIG. 5

FIG. 6

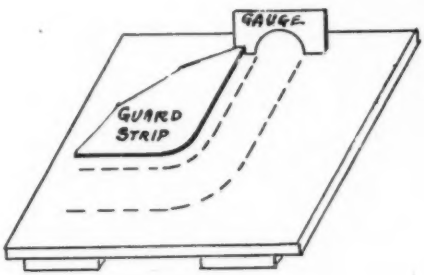


FIG. 4

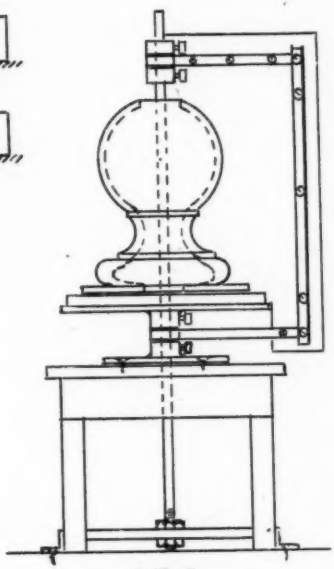


FIG. 8

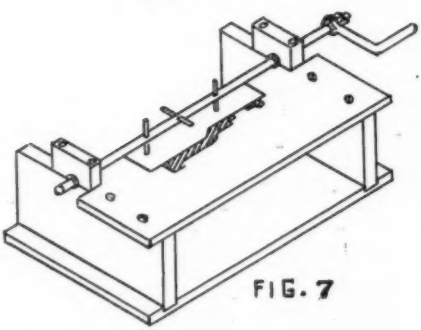
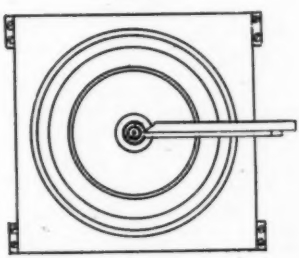


FIG. 7



PLAN

F. T. J.

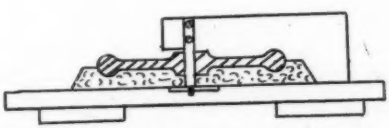


FIG. 9

the stucco, but in many cases, when only one casting is required, say for some special connection, the casting can be made direct from the stucco.

The introduction of stucco into the pattern-shop dates back to about the middle of last century, and since its introduction its practicability as a material with which to make patterns has increased very considerably.

Before going into the subject of practical stucco work, it might be well at this stage to give a short account of some of the methods adopted with certain classes of patterns prior to the use of stucco, and in this way we may be better able to appreciate the saving in time and material since its introduction. Let us take as an example a pattern for a "quarter" bend, with the usual faucet and spigot joints (see Fig. 1). One of these old methods of producing a pattern such as this was to make a block of wood to the exact size and shape of the core, jointed at the parting line, as the pattern was required in halves, in order to leave its own core.

This wooden block was then covered with sheet lead to the thickness of metal required, and it will be observed that owing to the shape of the block this covering with lead was no easy process, necessitating much cutting and soldering.

Thus, so far, we have only dealt with the plain part or body of the bend, leaving the faucet and spigot still to be worked out; this also required another elaborate process. A wooden pattern was turned in the lathe to the shape of the faucet and spigot, leaving a print or bearing at each end as shown on Fig. 2.

A mould was now made from this, and after the pattern was taken from the mould it was again placed in the lathe and turned down to the shape of the core, as shown by dotted line; this was placed in the mould and formed the core or mandrel.

After being cast in lead it was "cleaned up," cut in two, and the wooden core removed, keeping one of the parts full; this was then faced up with files to the exact half, and now the pattern for the faucet and spigot was complete. These halves were kept as original patterns, two halves were cast in lead from each of these and soldered on to the sheet lead which formed the body of the connection. Iron patterns were then made from each half, fitted and filed up in the usual way, making the complete shell pattern.

Another method adopted in some foundries was similar to that used in many engineering pattern-shops to the present day, viz., making a complete solid pattern in wood, with bearings at the ends, and then preparing a core box to suit.

These most expensive methods of pattern-making have been entirely superseded by the introduction of stucco.

In making the pattern of this same "quarter" bend in stucco, the following method would be adopted:—

In the first place two gauges would be required, one called the block or core gauge, and the other the outside or thickness gauge; these two gauges are similar except the diameter of the opening. Fig. 3 shows the core gauge and the dotted line shows the line of the outside gauge.

The gauges are usually made of sheet malleable iron, or from a thin plate of cast iron.

A wooden board is then required a little larger than the pattern to be made, also a thin piece of wood about a quarter of an inch in thickness, cut to the shape of the pattern. This is called the guide or guard strip, and is secured to the board.

Fig. 4 shows the board, guard strip, and gauge ready to receive the soft stucco, which is laid on the track of the gauge as marked by dotted line. The gauge is then moved along the edge of the guard strip, the stucco being "built up" until the block or core is to the exact shape of the gauge, as shown on Fig. 5. This block now receives a coat of shellac varnish and when dry is given a coat of oil; this oil is to the stucco worker as parting sand is to the moulder, it allows the thickness when run up to "come away" from the block.

Fig. 6 shows the outside gauge ready to sweep up the soft stucco, which is to form the thickness; this gauge is worked in the same way as the block gauge, viz., moved along the edge of the guard strip, and the stucco built up until it takes the form of the gauge.

The method of stucco work just described is called "guard work," and is by far the most commonly used, and it will be readily seen that the stucco might be made to take practically any shape, all that is required is to make the guard strip to the required form and work the gauge along it.

We have now to deal with the faucet and spigot; but before doing so, it might be well to state here that in all foundries where there is a "run" of this class of work, there are original patterns of faucets and spigots for all the standard sizes of pipes on stock, and when the stucco is run up it is only a matter of setting these into position to complete the pattern. The same remark applies to the gauges;

in all well-appointed hollow ware foundries there are already on stock these gauges to suit all the standard sizes of pipes, and when an order comes in for any connection of which there is no pattern, no time is lost in making these.

We will now deal with making the pattern of the faucet and spigot, as it takes us into another form of stucco work called "spindle work."

A spindle is erected on trestles as shown on Fig. 7, and pins are put in the spindle at intervals to guard against the stucco revolving.

A gauge is then placed on the trestle cut to the shape of the core of the faucet and spigot, and secured at a distance from the centre of the spindle to give the required diameter; tarred rope, or any other cheap material is then wound round the spindle to within a short distance from the edge of the gauge, the soft stucco is then built on the tarred rope, and the spindle is revolved by means of the handle at the end, and as the spindle revolves the stucco is formed into shape by the fixed gauge in the same way as a loam core for a round column.

When the block or core part is finished the gauge is removed, and the hatched part shown on Fig. 7 is cut out of the gauge, the block is varnished, then oiled, and the gauge is again placed in position and the thickness run on.

When finished only a half-pattern of each is used, and from these iron original patterns are cast, and stocked ready to be "set" on any connection which is run up. Another form of machine for stucco work is that known as the "vertical spindle" (Fig. 8).

This machine is more adapted for work of larger diameters than the horizontal spindle; all the parts are stationary except the frame that secures the wooden gauge, which revolves.

The sketch shows the pattern of a cast iron base for a flag staff, run up ready to be cut off. The casting for this base was made from the stucco, in actual practice, with a green sand core. Another method of sweeping up stucco is known as "centre" work; the centre from which this method derives its name is a small plate about an eighth of an inch in thickness, with two holes countersunk for screws and one hole in the centre. This plate is then sunk into the board on which the stucco is to be run up, making the top of plate line with the face of the board. Into this centre hole works a spindle which is flattened at one of the ends, and prepared with holes for securing to the revolving gauge. Fig. 9 shows a small wheel run up by this method; the gauge is first cut to run up the block part, and afterwards cut as shown to give the thickness.

If the wheel is wanted with arms, these must be cut out in the usual manner as if the pattern was in wood. It might be stated here that when a good "face" is wanted on the stucco, or when there are some features requiring sharp lines, the gauge, if in wood, should be faced with zinc; nothing gives a better line than a zinc-faced gauge.

In regard to the mixing of stucco, very little requires to be said, although one or two hints may not be out of place.

The basin, or box, for mixing should have the sides well tapered, to allow of the hard stucco being easily removed.

The hands should be well oiled before starting to mix stucco. The water should first be put into the basin, and the stucco added afterwards.

The water should be mixed with a little Irish lime to reduce the tendency of the stucco to swell. The work should be finished with as little delay as possible, as swelling is a very important factor in stucco work, and is apt to "tear off" the thickness if the gauges are worked too long.

In an article such as this it is not possible to do justice to such an extensive subject, and the methods described by no means exhaust the possibilities of dealing with this material, but can be taken as showing the main principle. The rest lies with the pattern-maker, who will find plenty of scope for exercising his ingenuity in working with stucco.

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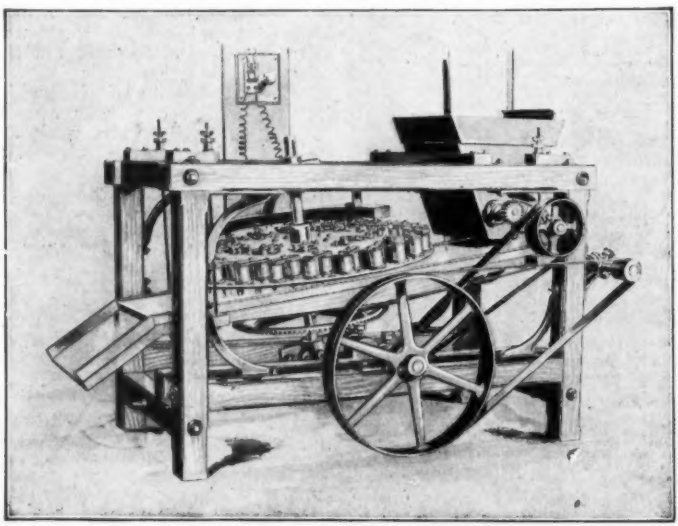
THE WOLVERHAMPTON CORRUGATED IRON COMPANY are transferring their works from Wolverhampton to Ellesmere Pond, near Chester.

THE Japanese Government have been supplying their army and navy, during the present war, with shells, etc., turned out at the Imperial Iron Works, Tokio. Already 866 orders have been executed, and in addition the works have manufactured 25,000 tons of rails for the Seoul-Fusan and other railways, and over 6,000 tons of light rails. The first smelting furnace at the Imperial Iron Works was opened in July of last year for the production of pig-iron. The maximum daily output of pig-iron from this furnace was 150 tons, and the second furnace was put into operation a month or so back. A Bessemer converter was opened in May of last year, and in November it turned out over 3,000 tons of steel.

THE DINGS ELECTRO-MAGNETIC SEPARATOR.

In separators of the revolving drum type the magnets are arranged inside a revolving drum, with the poles presented to the inside of the brass covering on the drum, over which the stock is fed. The non-magnetic material drops off the front of the drum, and the iron is supposed to be held against the brass covering until it is carried to the rear of the machine, where it is released or brushed off. However, it is both a mechanical and electrical impossibility to magnetise the whole surface of the drum in this way. There is not enough room in a drum to store magnet bodies in sufficient bulk to cover the whole surface with fully saturated pole faces. And, besides, the poles of magnets must be kept some considerable distance apart or they will neutralise each other by short circuiting the lines of force. It follows that in this type of separator, under the brass covering of the drum, there are only scattered poles or spots of attraction, and iron in passing over it must fall upon or near one of these spots else it escapes. The iron must also overcome by magnetic induction not only its own gravity, but the momentum and the blows and weight of the heavy non-magnetic stock around it, which is another cause for imperfect separation.

In the Dings Disc Separator this trouble is avoided by passing the stock in a thin sheet under the magnets, the conveyor motion and sweep of the magnets being so adjusted as to bring every part of the stock twice within a strong magnet field. The magnets are mounted upon a disc rotating over a conveyor, vibrated by means of an eccentric on the driving shaft. The magnets are automatically controlled, so that while over the conveyor they are powerfully charged, but while not over the conveyor they are demagnetised, allowing the iron picked up to drop at the outside of the machine, leaving the magnets clean for the next revolution; thus no device is needed to knock off the iron.



THE DINGS NO. 2 SEPARATOR.

The hopper is provided with a rotary feed and an auxiliary stirring shaft, which prevents any stoppage or choking up in the hopper, and feeds the stock on the conveyor in a thin or thick layer, as desired. Adjustments are quickly made for changing to a finer or coarser grade of stock. A device under the shaker keeps the stock agitated, so that no particles of iron can escape by being covered with heavy chips of brass, and a screen at the end of the shaker takes out the fine filings, etc., which can be used for special classes of castings.

The Dings No. 2 Separator shown in the annexed cut is designed for use in large brass manufactories, machine shops, etc. Its capacity is 400 to 1,500 lbs. per

hour, and its speed 400 revolutions per minute. The floor space required is 4 ft. by 6 ft. It can be ordered for any direct current up to 240 volts. The electricity required to operate the magnets is about the same as would be used in operating three ordinary 16-candle power incandescent lamps, the mechanical power being about ½ h.p. A switch panel with fused switch and pilot lamp is furnished with each separator.

In using the separator for brass stock it is found more satisfactory to have a machine large enough to clean up a week's supply of borings in a few hours than to keep a small machine running constantly. It often happens that a plant has a dynamo run for lighting purposes only, which is shut down during the day. In this case a capacious machine is found profitable, as the borings can be separated evenings or mornings, while the lights are being operated, avoiding the necessity of running a small dynamo especially for operating the separator. The "Dings" Electro Magnetic Separator is also made in a smaller size having a capacity of 200 to 400 lbs. of metal per hour. We are indebted to Messrs. J. W. Jackman, of 39, Victoria Street, S.W., agents for the sale of the separator, for the above particulars.

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CASTING MANGANESE BRONZE.—"The Metal Industry" contains an article on casting manganese bronze which is interesting to brass founders. As the alloy contains about half of its weight of zinc and some aluminium, it is difficult to cast. Dry sand moulds should be used if possible, though green sand will give passable work. The metal is best melted in crucibles well covered with charcoal, and should not be "burned." Pour as hot as possible without producing a rough skin, and skim well before pouring. Use skim gates to get off the dross, and keep the basin full all the time while pouring. Heavy feeders and risers are necessary, as the shrinkage in manganese is great. The head is not as important as the bulkiness of the feeders. Attach them to the top of the thickest part of the casting, making the necks as thick as possible. Attach the runner to the lowest part of the castings, making the metal flow upward into the mould. Cast all working surfaces downward, or if unavoidable to have them on top, leave extra metal to plane off. Add 1½ lbs. zinc each time the metal is remelted in crucibles, or 4 lbs. to the 100 if in the reverberatory furnace. This represents the melting loss in good practice.

MALLEABLE IRON CASTINGS.*

By C. O. BANNISTER.

FOR the cheap manufacture of iron articles requiring a fair amount of strength, it has been found convenient to first cast them and then to partially de-

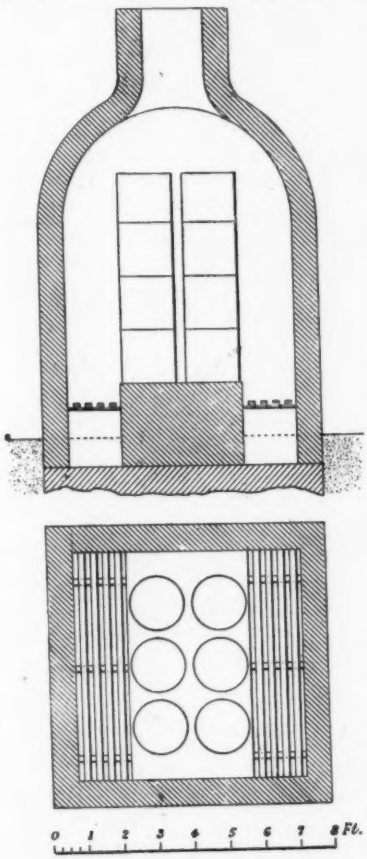

FIG. 1.—COAL-FIRED ANNEALING FURNACE.

carbonise the castings by an oxidising cementation treatment, thus producing a coating of malleable iron over a core of brittle cast iron. The articles thus made are known as malleable iron castings,

* Part of a Thesis presented for the Honours Associateship of the Royal School of Mines. This Thesis was incorporated in the sixth Report to the Alloys Research Committee of the Institution of Mechanical Engineers.

malleable iron or run steel. This process is specially useful for small articles of intricate shapes. Fairly large articles, such as propeller shafts, etc., have been made by this process and a subsequent operation for case-hardening.

Although this process was described by Reaumur in 1722, patents were only taken out in 1804 by Lucas and in 1850 by Brown and Lennox.

As modifications of the process, mention may be made of the method proposed in 1828 by Karsten, which was to submit iron castings to a glowing heat in a current of air; and of Tunner's method, proposed in 1846, which was to expose iron castings to a red heat in boxes filled with sand and allowing a regular admission of air; the action in this last method was sometimes aided by the use of substances which

FIG. 2.—ORIGINAL BAR, SHOWING CEMENTITE, PEARLITE OR SORBITE, 1,600 DIAMS.

provided oxygen, such as hematite, hammer scale, etc. Briefly, the process, as generally practised, consists of heating the castings packed in hematite to a bright red heat for several days.

The castings of the best Cumberland white or grey iron are made in sand moulds with or without chills, and packed with hematite in iron boxes. The hematite is crushed and passed through a 70- or 80-mesh sieve and mixed with used hematite from a previous operation, because the fresh hematite alone is too vigorous in its action. The mixture generally used consists of two-thirds used and one-third fresh, sometimes a mixture of half and half is used. Used hematite is sometimes reoxidised by the addition of a little sal-ammoniac and spreading it out in the open air.

The boxes, cast from a special mixture of white iron and scrap, vary in size, according to the size of the castings to be annealed, and may have a circular or rectangular horizontal section.

The furnaces consist of rectangular chambers, with dome-shaped roofs, built

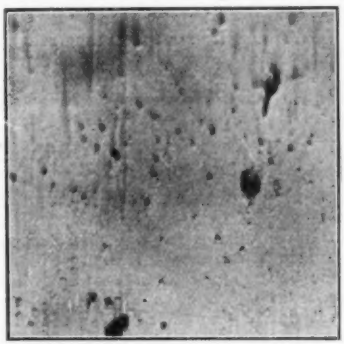

FIG. 3.—OUTSIDE OF BAR, 1,600 DIAMS.

in rows, each communicating with a flue which leads to a stack. The furnaces may be coal or gas-fired; Fig. 1 represents a coal-fired furnace, such as is generally used in the Midlands. The middle portion of the bed is raised, thus providing two passages down the sides for the fires. The boxes containing the castings are placed on this raised floor, three or four in each pile, the joints between them being sealed

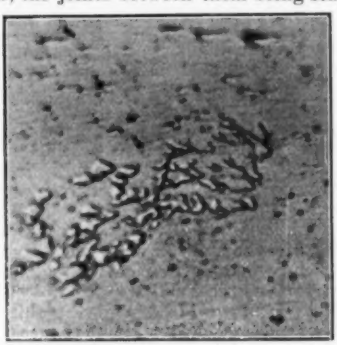

FIG. 4.—SECOND POSITION.

with fire-clay or wheel swarf, and the top box is completely covered with the same substance. Each furnace holds from twelve to twenty boxes. After the fires have been started, a bright red heat (between 1,000 degrees C. or 1,832 degrees F. and 1,100 degrees C. or 2,012 degrees F.) is maintained during the day; at night the ovens

are damped down and only a dull red heat obtained, until the fires are again made up in the morning. This heating goes on for several days, from five to nine according to the size of the castings and the degree of decarburisation desired; after the furnaces have been allowed to cool for

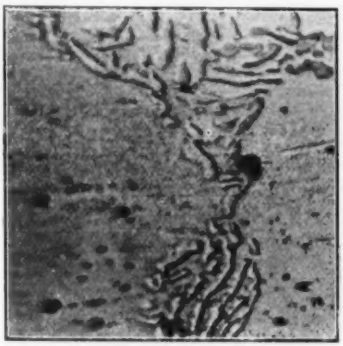

FIG. 5.—THIRD POSITION.

one or two days, the boxes are withdrawn and unpacked. The middle boxes of each row are found to work most evenly, and the most important work is always packed in these.

The great objection which prevents this process from being much more extensively used is the presence of small quantities of slag and blow-holes in the castings,

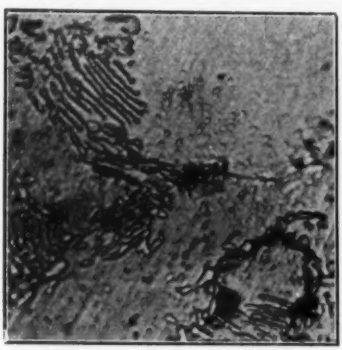

FIG. 6.—FOURTH POSITION.

which greatly reduce their strength, introducing an element of unreliability.

Much experimental work has been done in order to investigate the changes which take place in the composition of the iron during this process, the increase of strength, the most suitable cement, and the correct time of cementation.

The most important conclusions arrived at are :—

1. A malleable casting always contains amorphous carbon.

2. A casting may lose carbon and still remain fragile if the remaining carbon is not in the form of graphite, or if the

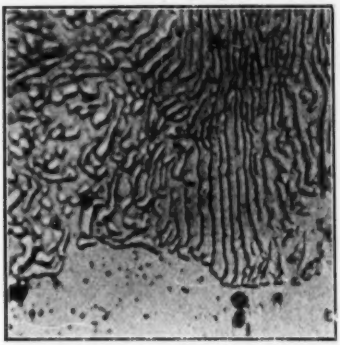

FIG. 7.—FIFTH POSITION.

initial quantity of graphite is not increased.

3. A casting may become malleable without a sensible loss of part of its total carbon.

4. In general practice the castings lose on the total carbon, and some of the combined carbon is converted into finely-divided graphite or temper carbon.

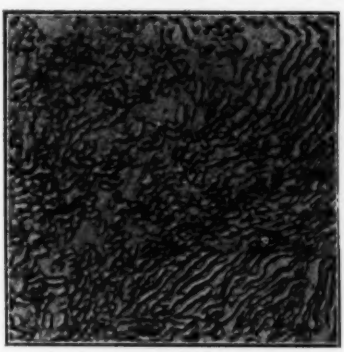

FIG. 8.—SIXTH POSITION.

5. The castings generally lose some sulphur, which is found in the hematite in such a form as to evolve sulphuretted hydrogen on treatment with acids.

6. As a rule the other constituents of the castings are not altered to any appreciable amount.

The following work has been done to show by means of analyses and photo-micrographs the changes which take place during the operation. The preparation of the samples was left in the hands of a practical man, so the results are such as would be obtained in commercial objects.

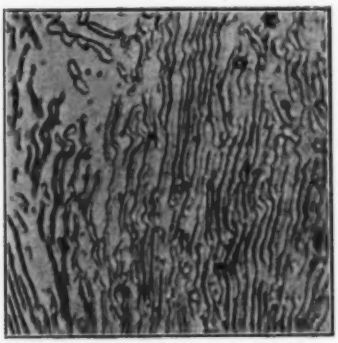

FIG. 9.—SEVENTH POSITION.

An analysis of the original bar gave the following figures :—Combined carbon, 2.53 per cent.; graphitic carbon, nil; sulphur, 0.36 per cent.; phosphorus, 0.036 per cent.; silicon, 0.707 per cent.; manganese, 0.185 per cent.

Fig. 2 is a photo-micrograph of the

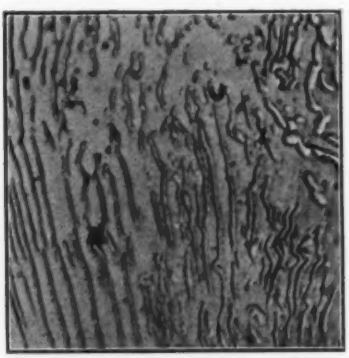

FIG. 10.—EIGHTH POSITION.

iron magnified 1,600 diameters, and shows cementite and confused pearlite or sorbite. Sorbite is practically pearlite in which the laminæ have not separated, and cementite is carbide of iron.

A photograph of a cross section of the bar after being annealed in hematite, polished, etched and magnified about three times, shows how the decarburisation has taken place from the outside, with the formation of graphitic carbon towards the centre. The analysis from the whole of a drilling through the bar gave :—Combined carbon, 0.74 per cent.; graphitic carbon, 1.33 per cent.; sulphur, 0.33 per

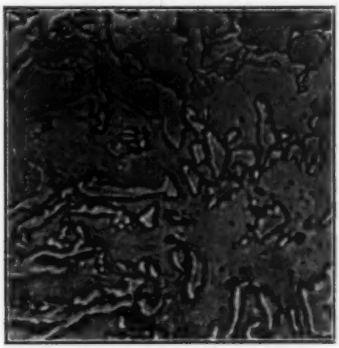

FIG. 11.—NINTH POSITION.

cent.; phosphorus, 0.04 per cent.; silicon, 0.667 per cent.; manganese, 0.192 per cent.; total carbon, 2.07 per cent.

On comparing these figures with those given before, we find that the total carbon has been reduced from 2.53 per cent. to 2.07 per cent., that 1.33 per cent. carbon

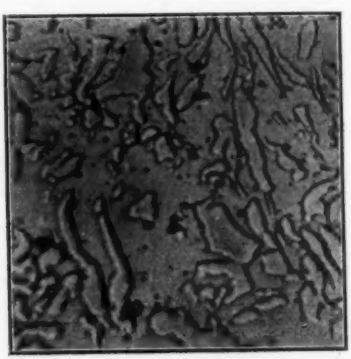

FIG. 12.—TENTH POSITION.

originally in the combined state has been converted into the graphitic condition, that the sulphur has been reduced by 0.03 per cent., and that the other constituents have only slightly varied.

The photographs, Figs. 3 to 15, are a series taken from the outside to the centre of the annealed bar magnified 1,600 times,

showing the gradual change in the iron. The graphitic carbon is so finely divided that even at this magnification it is difficult to detect.

Theory of the Process.—The temperature of the annealing furnace is carefully kept somewhere between 1,000 degrees C.

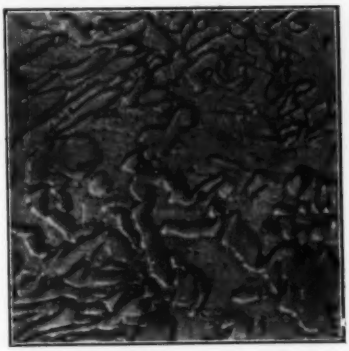

FIG. 13.—ELEVENTH POSITION

(1,832 degrees F.) and 1,100 degrees C. (2,012 degrees F.), and it is a well-known and fully accepted fact that at a temperature of 1,050 degrees C. (1,922 degrees F.) cementite (Fe_3C) is dissociated into its constituent elements and produces a solid solution of free carbon in iron. Dr.

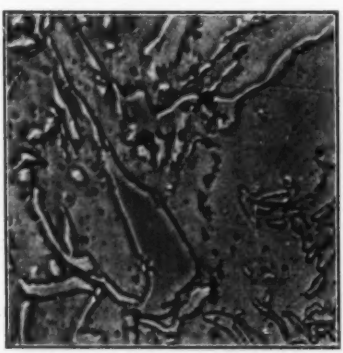

FIG. 14.—TWELFTH POSITION.

Stansfield has shown that when cast-iron is heated and allowed to cool slowly the carbon separates out as graphite, being less soluble in this form than when present in the form of cementite. At the annealing temperature the cementite is dissociated and the graphite is left in a very finely divided condition. The reason the graphite does not crystallise is probably because: firstly, there is a certain mechanical opposition in the mass, caused by the separation of the graphite, which occupies more space in this condition than it does when in solution; secondly, there was no crystalline graphite originally present in the bar which would have formed

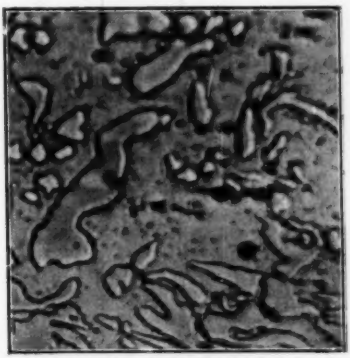

FIG. 15.—CENTRE OF BAR.

nuclei around which more graphite could collect.

On referring to the diagram, Fig. 16, showing the distribution of carbon in the

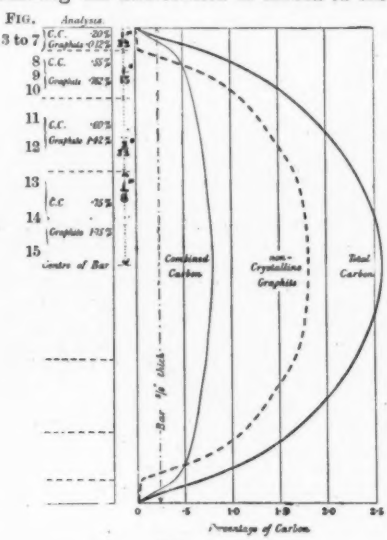

FIG. 16

annealed bar, it is found that after a certain point 0.5 per cent. carbon is reached, although the graphite increases from this point to the centre of the bar

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by 1 per cent. the combined carbon only increases by 0.3 per cent. The reason the amount of combined carbon is less near the surface of the bar is because the mechanical opposition to its dissociation is not so great, and therefore allows of the separation of the graphite to a greater extent.

During the decarburisation of the bars there are two opposite actions continually at work. On the one hand there is the oxidising action of the cement (in this case hematite) on the outside of the bars, oxidising the carbon by solid contact, and also by gaseous diffusion according to the equations :—

$$2\,Fe_2\,O_3 + 3\,C = 4\,Fe + 3\,CO_2$$
$$CO_2 + C = 2\,CO.$$
$$Fe_2\,O_3 + 3\,CO = 2\,Fe + 3\,CO_2$$

thus producing iron free from carbon (ferrite). On the other hand there is a store of carbon towards the centre of the bar in the form of non-crystalline graphite, which is continually recarburising this ferrite by solid diffusion. These actions continue as long as a temperature of 1,050 degrees C. (1,922 degrees F.) is maintained, but on lowering the temperature they cease, and the final product is as shown in Fig. 2.

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During the past month Mr. Justice Channell, sitting in the King's Bench Division, has heard the case of Watson *v.* Watson & Company. This was an action by Mr. S. B. Watson, iron and steel merchant, of Workington, Cumberland, who sought to recover from Messrs. James Watson & Company, of Middlesbrough, a balance due for goods sold and delivered, and also seeking damages for alleged breach of contract to take a quantity of hematite pig-iron sold as "mixed numbers." This term, the defendants said, meant that it must be up to a certain standard of analysis, and that, as the iron was not up to the standard, they were justified in refusing the balance. His lordship, in giving judgment, held that there was no such universally understood standard as to make it an implied term of the contract. At the same time, he found that the iron was not so good as the defendants had the right to expect, and that the plaintiff was not entitled to damages in respect of the undelivered balance. He also held that the defendants were entitled to the allowance made to their sub-purchasers. Judgment accordingly.

CONTINUOUS PROCESS FOR CAR WHEEL MANUFACTURE.

No branch of the iron and steel industry offers wider possibilities for the production of duplicate parts than the foundry trade, and in the past few years many continuous processes have been tried with more or less success. Labour troubles in foundries have fostered the moulding machine, and the further replacement of skilled labour by the unskilled and cheapening of labour costs will bring about continuous processes. At Pittsburg a continuous steel belt was tried in one of the largest shops for conveying moulds to the casting floor, and

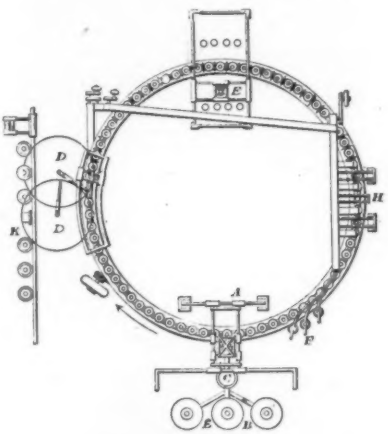


Fig. 1

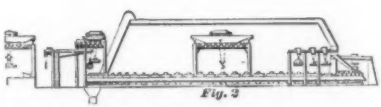


Fig. 2

CONTINUOUS CAR WHEEL MOULDING AND CASTING PLANT.

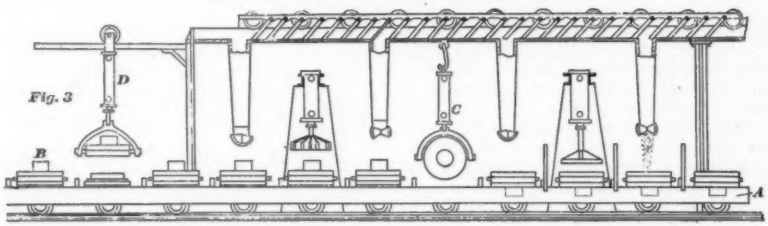
practically all continuous processes tried have been designed to prevent the shaking down of moulds when taken from one floor to another. The steel belt was discarded as it was impossible to prevent the vibration, which resulted in the destruction of an unduly large percentage of moulds. At another specialty shop the moulds were placed on floats in a large water tank, but the tipping of floats with the consequent destruction of the moulds soon resulted in the system being discarded. Outside of the car wheel line, no attempt has been made at operating continuously with a pro-

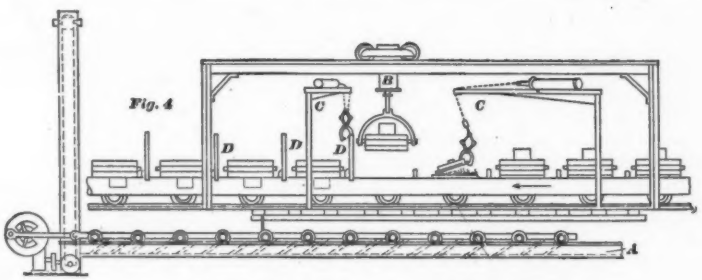
cess that combines moulding, casting, and stripping.

For nearly two years car wheels have been successfully made at a plant near Pittsburg by the Sherman process, the invention of C. W. Sherman, of Bellevue, Allegheny county, Pa. Mr. Sherman's wide experience as a car-wheel manufacturer led him to the conclusion that the installation of a continuous process and a division of the work on each wheel would facilitate the manufacture, better the product, and effect a saving in the labour. We are indebted to the "Railway Age" for the following particulars:—

pattern withdrawn, the mould is ready to be poured. The coping device is shown at F, Fig. 1. The sand-ramming devices shown in Fig. 3 have not yet been used, this work now being done by hand. The pouring is accomplished by the use of a bottom pouring ladle as the mould passes the pouring crane A, Fig. 1, the iron being supplied in the usual manner from cupolas B and ladles C, in Fig. 1. The stripping of the wheels is done at a cherry-red temperature near the annealing pits, the pits being indicated by K, Fig. 1, the scope of the pouring and stripping cranes being such as to allow the proper time between

ELEVATION OF MOULDING DEPARTMENT.





ELEVATION OF STRIPPING DEPARTMENT.

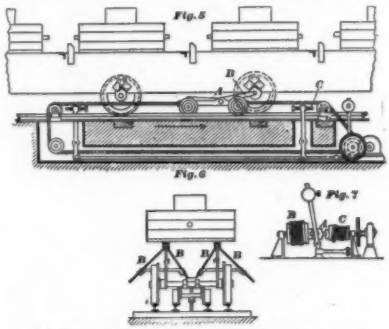
As shown in Fig. 1, the plant consists of an endless track and mould conveyor 100 ft. in diameter, with space for 72 car wheel flasks. Each flask is allowed approximately 52 in. of space on the ring. The movement of the conveyor is intermittent and the distance moved is equal to the space occupied by one flask. The moulding is accomplished by the use of ten patterns, and each pattern is placed in a flask at A, shown in Fig. 3, which is an enlarged elevation of the moulding section. As the flask moves from point to point sand is fed from overhead spouts at point H, in Fig. 1, and each man does that portion of the work assigned to him, and this labour is the same on every wheel. When the flask leaves point B, Fig. 3, with the pouring and stripping each wheel, regardless of the speed of moulding and melting. The wheel casting is removed with crane D, Fig. 1, from the conveyor car, and placed in position for the pit, in one operation. The pitting crane is at G, Fig. 1. As the sand is removed from the wheel it drops into conveyor A, Fig. 4, and is automatically screened, mixed, and tempered, as shown in Figs. 8 and 9, while being conveyed to the moulding section and the empty flask is replaced on the conveyor and passes under crane E, Fig. 1, where it is removed and a cold one placed in position ready for use. About 1 hour and 45 minutes is required for a flask to make a round of the entire operation, and in operating 10 hours a day the same flask

can be used twice, thus effecting a saving in a foundry's flask equipment of about one-half.

The track construction on which the conveyor moves consists of 70-lbs. T rails curved to the proper radius and resting on ordinary cross ties. Figs. 5 and 6 show an endless conveyor, but the present installation consists of a system of cars, each holding two flasks and made of upright plates A, Fig. 6, and aprons B, of bent plates, forming a protection for the wheels which operate loose on the axles and also the rails at the stripping and moulding sections to prevent any loose sand from blocking the track.

The radial axles have the distance from the axle of one car to the axle of the next, the same as between the axles on the same car, and the cars are coupled by a universal device, which will be simplified by the use of a continuous conveyor. Figs. 5 and 6 show a side view and cross section of the conveyor at the operating point. Trolley A, Fig. 5, is so applied to the conveyor as to allow the return movement without engaging the axles. Dog B works against the axle on its forward movement only, and the trippers C C act on the clutch A, Fig. 7, and reverse the movement of the trolley from either direction while the motor runs steadily forward making the movement automatic. The trolley track inside the conveyor track in Fig. 6 extends only the distance of the operating mechanism. The propeller is connected to drums B and C, Fig. 7, by a wire cable shown in Fig. 5, and by referring to Fig. 7 it will be seen that one drum is loose on the shaft while the other is in operation, and *vice versâ*. The drums shown are of different sizes, to proportion the periods of travel and rest for the main conveyor and allow the proper time between movements for doing the work at various points on the circle. It has been found that a 15-h.p. motor is sufficiently large to move the whole train.

Fig. 3 shows the reciprocating sand conveyor and down-spouts for feeding the sand to cope and drag sections of the moulds. The gates on the sand spouts operate by a lever. The roll-over hoist C in Fig. 3 is at a convenient point to roll the flask over immediately after the bottom board has been fastened, and the coping device D travels in line with the centre of the conveyor and leads off the centre line in Fig. 1 at F. Fig. 4 shows a pneumatic crane B, which travels in line of the conveyor and the wheel-removing cranes C and C. The stripping operation is carried out as follows: Crane B removes the cope, chill, and drag from the casting and replaces the flasks on the conveyor in a vacant space ahead, and the wheel is taken from the conveyor by ordinary wheel tongs operated by pneumatic jib crane C, and deposited in position for the pitting crane G, Fig. 1. The bottom board is then placed in an upright position at D, and all the remaining sand drops through the cars and open track into conveyor A. The car and grating construction around the stripping section prevents any chunks of iron or scrap from falling through which cannot be easily handled by the conveyor A and removed from the sand by screen A in Figs. 8 and 9. The sand passes along conveyor A, Fig. 4, into screens A, Figs. 8 and 9. This mixer has a system of paddles attached to a shaft for thoroughly mixing the sand while it is being cooled and tempered. The sand is discharged at the

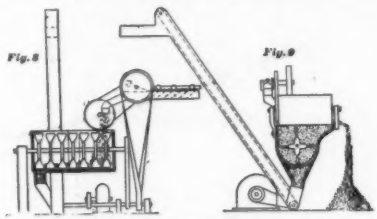


MOULD CONVEYOR AND PROPELLING DEVICE.

opposite end into elevators and conveyors for delivery to the moulding section ready for use.

The advantages of the system are many, resulting in uniform moulding with comparatively unskilled labour, each man confining himself to one moulding operation, and an intelligent labourer can be taught his portion of the work very quickly. It has been found by actual operation and in the production of 400 wheels daily the average moulding loss is about 2½ per cent. All the pouring is done at one point near the mixing ladle, which avoids variations in temperature of the iron poured owing to its conveyance to a distant portion of the shop or near the cupola in an old system shop. The time of stripping all wheels is under the control of the man in charge, which insures the pitting being done at the proper temperature, and the wheels follow each other uniformly, exactly the same time elapsing between

the pouring and pitting of every wheel. This is impossible under the old floor system, where the wheels are conveyed variable distances before pitting. By this continuous system the heat from the pouring and stripping is entirely removed from the moulding section, and all wheels are stripped and pitted in the shortest time possible, reduces the loss of heat by radiation, bottles it up in the pit for annealing, and avoids roasting the men at the work.



SECTION THROUGH SAND SCREEN AND MIXER.

A trial of this system through two summers has proved the pouring and stripping to be much easier than under the old floor system, and is due to the fact that only one ladle of iron and not more than two wheels are radiating heat in the shop at the same time. Under the old system each moulder and helper handles 4½ tons of sand three or four times a day, which is done mechanically by this improved method, the whole operation of handling the sand, molten iron, hot wheels and flasks is reduced to a minimum, and Mr. Sherman is now perfecting a moulding device to complete the cycle of mechanical operations necessary to the manufacture of machine-moulded car-wheels.

The number of men required to operate a plant equipped as shown in the drawings is about 35, at a total wage cost of £17. This number of men will produce 350 good wheels in 10 hours, which makes a total cost of 1s. per wheel from moulding to pitting inclusive, and is a saving of 10½d. per wheel from moulding, with 1s. 5½d. for moulding, and 5d. additional for foundry labour under the old system.

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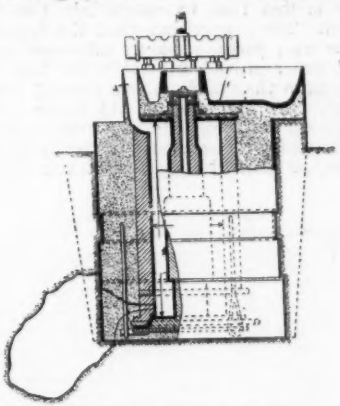
IN connection with the Universal Exhibition, to be held this year at Liége, Belgium, the Association of Engineers of Liége are organising a congress of metallurgy, mechanical engineering, etc., and they have invited the members of the various British technical institutions to co-operate with them at the congress, which will be held at Liége from June 26 till July 1.

EXPLOSION OF A MOULD.*

SEVERAL interesting features are exhibited by an explosion which occurred some time back, with fatal results, during the casting of a hollow 6-ton roll. The mould was erected in a pit in the foundry floor, the pouring gate being about 40 in. above the floor level. The molten iron was conveyed in a ladle by means of a travelling crane, a gang of men being employed in hauling on the chains as ordered by the foreman in charge of the pouring. The operation was just completed, and the crane about to be moved away, when the foreman noticed a suspicious movement of the upper part of the mould, this being immediately followed by a dull explosion underneath the floor, and an eruption of glowing iron, sand, dust, and steam. The lights went out, and the men at the crane, being unable to escape fast enough in the dark, were overwhelmed by the hot metal, six being burned to death and five seriously injured.

The investigation of the accident failed to thoroughly elucidate the cause, so this



THE EXPLOSION OF A MOULD.

can only be surmised. The iron was found to have burst out at the bottom of the mould into the damp sand, the rapid evaporation of moisture generating sufficient steam pressure to blow away the upper layers of sand and drive out at the same time large quantities of glowing metal. This explosion made such a large cavity in the earth that the whole of the metal ran out of the mould and was found in the state of a shapeless block of extremely spongy character.

The construction of the mould was the

* "Stahl und Eisen."

same as usual, several hundred similar rolls having been cast before. The base of the mould, with core, was built up of brick on a cast iron plate, dried, coated with loam (which was then sleeked with a templet), blacked and dried in the oven. The outer cover of the mould (½-brick thick) was built up of burnt bricks on a separate cast iron ring, and, when finished, was mounted on the bottom piece, the joint being well luted, and the whole fastened together with iron clamps. The finished mould was lowered into a deep pit and surrounded with a sheet iron cylinder, about 32 in. wider than the mould itself, the intermediate space being filled with rammed sand to strengthen the mould. The space between the cylinder and the walls of the pit was also filled with sand, rammed in the usual way. The metal was poured through four gates, and a vent was provided at one side of the mould top.

The inspection of the mould after the accident showed the same to be quite empty and in good condition, except that one of the bricks near the bottom had got out of place and thus left an orifice for the molten iron to escape into the wet sand. The supposition that the foundry floor was, perhaps, partly saturated with soil water proved untenable, the floor being more than 20 ft. above the soil water level. Furthermore, an old boiler with the head removed and the interior filled with sand, had been sunk vertically in the floor, so that the upper rim was 10 ft. below the floor level, in order to drain off any water.

To prevent similar accidents it is advisable to provide the lower ring of the cylinder enclosing the mould with a solid bottom, so as to form a sort of tray which would retain any iron escaping from the mould; at any rate, such an arrangement would minimise the consequences of any escape of the kind.

MOULD DRYING METHOD FOR STEEL CASTINGS.

Forgings are gradually being replaced by cast steel in the construction of locomotive frames, not only on account of the lower cost of the steel, but because the steel suitable for frames shows a tensile strength of about 75,000 lbs. per square inch as compared with 53,000 to 54,000 lbs. per square inch for the best hammered iron. In addition, the cast steel frame is practically homogeneous, having no welds, and is of uniform texture throughout its entire length. Furthermore, the number of projections required for the reception of brake work, tumbling shafts, rocker pins, etc., seriously complicates the production of the frames of hammered iron, whereas the reverse is true in the manufacture of cast steel frames.

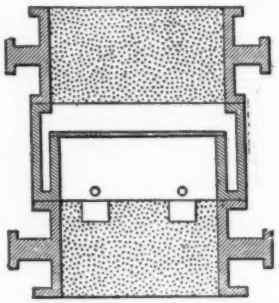


Fig. 1.—Method of Placing Cope over Drag.

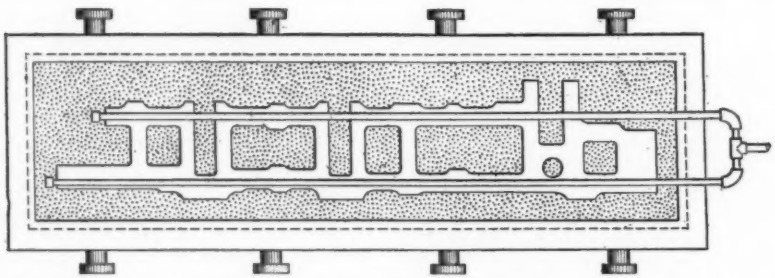


Fig. 2.—Piping Arranged for Drying Locomotive Frame Mould.

Owing to the length of the frames, varying up to nearly 40 ft., considerable difficulty has been experienced among steel casting manufacturers in producing them

without shrinkage cracks and the consequent loss of an unduly high percentage of castings. C. C. Smith, of the Union Steel Casting Company, Pittsburg, U.S.A., has a patented method of drying moulds in his plant by which this difficulty has been entirely overcome. The common practice of drying the moulds throughout is objectionable in the manufacture of large steel castings, not only on account of the danger of injuring the mould in its removal to the drying oven, but also because the baked mould does not break or disintegrate under the shrinkage of the casting, and as a result the latter becomes strained and frequently full of shrinkage cracks. By the new method only the face of the moulds is baked, leaving the main body easily friable, so that the mould will readily break down under the strains due to the shrinkage of the casting.

In drying the mould the cope is superimposed on the drag and a perforated gas pipe is introduced between them, the gas being burned in the mould cavity between the cope and the drag. A flask section is placed between the cope and the drag to hold them some distance apart, and to prevent the drying of the cope to a greater extent than the drag a baffle wall of thin metal prevents the flame from coming in contact with the cope face. The heat can be continued for any length of time, so as to get thoroughly dry mould faces. While the face of the mould will become dry and hard the greater portion of the mould body will still be moist and will easily disintegrate or break down. In the drying of moulds for locomotive frames two perforated gas pipes are used, as in Fig. 2. This method of drying can be carried out on the moulding floor, not necessitating the removal of the drag or cope to a drying oven, the cope receiving a minimum amount of handling, while the drag is not moved at all. The Union Steel Casting Company has been successfully making locomotive frames by this method for the past year and a-half and is at present producing six daily.—"Iron Trade Review."

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The first meeting of the North-East Coast Association of Secretaries, which consists almost entirely of secretaries of shipbuilding, engineering, iron and steel, and foundry companies, was held recently at Newcastle-on-Tyne, the President, Mr. Malcolm Dillon, occupying the chair. The meeting elected 35 new members, and Mr. Matthew Murray, of the Wallsend Slipway, was appointed treasurer of the Association.

THE BRYAN VACUUM MOULDING MACHINE.

Mr. M. L. Cramer, of the Snow Steam Pump Works, read an interesting paper on "Moulding Machines" before the Buffalo Foundrymen's Association, the object of the paper being to set forth the advantages of the Bryan vacuum moulding machine, an invention of a practical mechanic. The following is an extract from the paper:—

All so-called moulding machines are nothing more than pattern drawing machines, and the pattern drawer that meets all requirements, that costs the least money for installation, and is the least expensive for pattern outfits is the ideal machine. All moulding machines but one draw the pattern downward, while flask is stationary, or shove the flask upwards while the pattern is stationary, with great risk of sand following the pattern, due principally to the combined weight of sand and the suction following the disturbance of the pattern while leaving the mould, and breaking the sand bond. This is true with stripping plate machines as well as vibrating machines with downward movement of patterns. With the Bryan machine, the patterns are drawn above the sand just the same as drawing patterns from moulds as done by hand, with the exception that the pattern is drawn with a greater degree of accuracy, with no moulds to patch. Especially is this the case after pay day. If the sand were a trifle dry, and the pattern was to be drawn downward or below the sand, it is quite evident that the sand would be more liable to fall away from the flask and pattern by its own weight, when disturbed by the drawing of pattern, than when the patterns are drawn above the sand.

It has been determined by experience of foundries using the Bryan machine that the average cost of each set of patterns assembled and secured to boards is about 33s., and only about 16s. 6d. for a pattern having all developments, both sides of the parting lines alike, requiring but one pattern for the making of a complete mould. A pattern of this construction is provided with a removable dowel pin that enables the machine operator to match both cope and drag by the omitting and replacing of the pin as required.

Hand patterns are, as a general thing, made in two pieces, one for cope and one for drag. Take the two half patterns

and mount them on the same board, and you can readily see the great advantage derived from this system above hand moulding in increased output and accuracy in moulding true to form of pattern. A certain shop employed 11 bench moulders at the time the Bryan system of moulding was introduced. In less than two weeks thereafter two inexperienced men were doing the work of the 11 bench moulders, doing more and better work with one moulding machine. The machine was mounted on a post, having two work benches with frame of sucker rod free to swing from one operator to the other.

It has been determined that the cost in mounting of patterns on boards for use in the machine has saved in weight of castings machine moulded, in one day, in comparison with castings made from same patterns moulded in the usual way by hand. The saving was due to the castings made by the machine method being uniform and exactly to the size of the pattern, while identical castings, a result of hand moulding, each weighed 1¼ lbs. more, this increased weight being caused by excessive rapping of pattern in order to draw by hand.

A machine which will make green sand cores at the same operation of making the moulds, doing away with patching and not requiring a nail to hold cores in place, can easily be seen to have advantages, as it does away with considerable core making. It has further been shown that in moulds made from patterns having long cores, when drawn by hand the green sand cores would shift and break as the metal struck them, unless nailed —this necessitating machine work on the castings, drilling out imperfect holes. With the machine drawn mould, the cores remain perfect, require no patching, and turn out a casting with holes as smooth as the rest of the casting.

Either snap or fixed iron flasks can be used. The fixed flasks, however, are preferable, owing to the fact that they hold their shape and are more durable. It may be true, perhaps, that such an outfit may cost more, but experience has taught us that every dollar judiciously spent for improvements in the foundry outfit will bring handsome returns in the way of an increased output. Further, if by the addition of a machine to your foundry equipment at a small cost, you can reduce your labour item to one-fourth of what it now costs you on green sand and core work, it is a question that should be investigated without delay.

There has been added to the equipment of the Bryan machine a new feature in an air ejector, by the use of which a vacuum is created with compressed air. This takes the place of an expensive vacuum plant for the use of the foot power vacuum pump. It requires about 60 to 76 lbs. of compressed air to operate the air ejector and to maintain a vacuum equal to lifting a weight about 140 lbs.

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MAKING FILLETS IN PATTERNS.

When finishing the junction between two parts of a pattern which join each other at a considerable angle, some kind of a fillet should be put into the apex of the angle. An old pattern-maker was accustomed to illustrate the use of fillet by holding up his hand with the fingers spread apart, and pointing to the delicate curve which joined each finger to the other, would say: "There's a fillet pattern for you. Always make fillets join the surfaces just like that, and the work will always look well and never crack." Three kinds of fillets are in general use, the wood, the leather, and the wax. In large work, the wood fillet, glued strongly in place, and worked out to a nice curve, answers the purpose. On rough work, the leather fillet can be put quickly into place, and by soaking in water, can be readily bent around curves and into quite short corners. It is glued and nailed in place, and can be used on the better classes of work by soaking or brushing over with a solution of nut galls. Only the glue surface need be treated, and the treatment is solely to make the glue take better hold of the leather. The wax fillet is especially adapted to fine work where corners of one-eighth, one-quarter, and three-eighths of an inch diameter are to be put in. A tool must be provided for each size. Pieces of plain round steel, squared off at the end and well polished, will answer well. One end of each piece should be left straight, the other end ought to be bent to a rather short angle, say to a radius equal to the diameter of the tool. This will enable corners to be put into close quarters, also in circular sweeps, etc. To apply a wax fillet, heat a piece of steel kept for that purpose and with it melt the wax into the corner, putting in a sufficient quantity to make the fillet, an excess will do no harm; then form with the tool of right diameter and remove the extra wax with a chisel.

MOULDING BOX FOR CURVED PIPES.

To facilitate the casting of curved pipes of large diameter, Mr. J. Mehrtens, junr., of Essen, Germany, has introduced the mould illustrated in Figs. 1 and 2. As

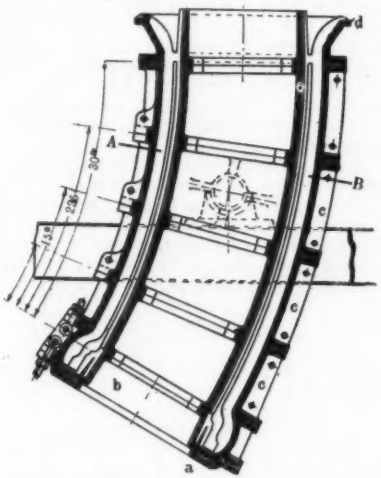

FIG. 1.—SECTION THROUGH C D FIG. 2.

can be seen from the general arrangement, the castings can be moulded and cast in an upright position, just like ordinary straight pipes. The box and core are built up in segments, *c*, the height of the segments being so selected that

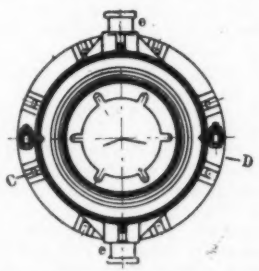

FIG. 2.—SECTION THROUGH A B FIG. 1.

lengths with a curvature of 15, 22½, 30, or 45 degrees (the ordinary types) can be cast without difficulty. The flanges on the segments are tongued and grooved, and are tightened up by the aid of bolts.

The mould can be produced by means of either patterns or templets; and the box is divided into two longitudinal parts (Fig. 2), in order to facilitate the removal of the pattern after moulding. To prevent any shifting of the core in the mould, the lower part, *b*, fits exactly into a recess in the bottom plate, *a*, and is held in place by guide studs. A firm support to the mould, while the metal is being poured, is afforded by the provision of trunnions, *e* (Fig. 2), on one of the segments. The pouring gate consists of a specially shaped upper ring, *d*, and the gates are arranged in such a manner as to prevent slag getting into the mould.

It is claimed that by this system the castings are produced at much lower cost and with greater accuracy, uneven thickness of metal being easily avoided; and the absence of core holders improves the appearance of the pipes. There is also a considerable saving in moulding material and coke. The initial cost of the box is rather high, however. A patent has been applied for.

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SHODDY PATTERNS AND CORE-BOXES.

By J. E.

"THE rapid destruction of wooden patterns and core-boxes by moulders and coremakers in the foundry is a matter which calls for serious comment. It is very distressing to see patterns and core-boxes, fresh from the pattern-makers' hands, beautifully finished and varnished, sent into the foundry, and then knocked about and wrecked by unscrupulous foundrymen."

This is the usual dictum of a great many pattern-makers. Well, let us look into the matter a little closer, and, from an unbiassed point of view, try to find a remedy.

It has been said by some moulders and pattern-makers, too, that the whole matter rests with the pattern-maker and the management.

All the faults and shortcomings of the patterns are, and must always be (according to the moulder), rigidly attributed to the pattern-maker's absence of knowledge of the details of foundry work, or the short-sighted policy of the heads of the firm to have patterns made as cheaply as possible, totally disregarding the extra cost of producing the casting from such patterns.

There are some moulders who are so heavy-handed that it is almost an impossibility for them to handle patterns or core-boxes without injuring them in one way or other, however substantial they may have been made. On the other hand, there

are moulders who are so very intelligent in their methods of moulding that it is quite a pleasure to see the patterns after having been through the process of moulding.

I was told recently of a foreman moulder who asked "that a certain pattern should be made of the best material, rounded corners, fillets worked in, and plenty of taper where possible, and plates for rapping and drawing." The reply he received was somewhat in the following vein: "Do you want to put the pattern on the drawing-room table?" However, let that pass. Every practical moulder knows so well that the better the patterns are made for moulding purposes (and, be it remembered, that this is the only purpose for which patterns should be made) the better and greater are the chances of getting good and cheap castings. If a mould is damaged to any extent by a badly-made pattern, the cost of finishing that mould will, in some cases, run up so high that the employer stands a good chance of losing on the job, besides prohibiting him in future from entering into competition for work of a similar nature.

It is very gratifying to know that some firms are alive to this, and are insisting upon having their patterns made properly. On the other hand, there are yet some firms who think that the mainstay and salvation of their works is the pattern-shop, and so fall into the false economy of making patterns cheap. It is a great mistake of the management to cut the price of patterns down so low that the pattern-maker cannot possibly make a mouldable pattern, and as the foreman wishes his department to pay, he tries his level best to come inside the price fixed; and so patterns and core-boxes are jerry-built and shoddily made—no rounded corners, no taper, no rapping or drawing plates. The moulder has not the same regard for the patterns that the pattern-maker has, and is compelled to burn holes in the pattern for rapping, and to drive screws into it for drawing. Under these circumstances, can anyone be surprised that the destruction of patterns is so rapid?

Pattern-makers do not seem to realise the fact that all patterns are subjected to an enormous strain every way—first, by the damp sand being rammed onto them, then the rapping, and, finally, the drawing out. Some men say that the rapping of patterns is quite unnecessary, but they are greatly mistaken therein, for all patterns must be rapped, more or less, according to their formation.

Shoddy patterns take an enormous amount of time and patience to draw them out of the sand, the moulder first starting at one corner, then another, rapping here and there, then calling other moulders to assist him, some with long bars, using them as levers to start the pattern with, others to hold the joint down with boards, and the moulder in charge of the job swearing like an old-time man-o'-war's man, and heaping execrations upon the author of all his trouble.

When at last the pattern is out of the mould, the sight presented by the broken and disturbed sand is one calculated to try even Job (who, by the way, could not have been a moulder, nor could he have known anything of foundry work, or his reputation for patience would surely have vanished).

A few extra pounds spent upon patterns will very soon be saved in the foundry and fitting-shop. Let us take a case which occurred only a short while ago. At a large firm of engineers, whose speciality, among other things, was high-class horizontal engines, the bed-plate of which used

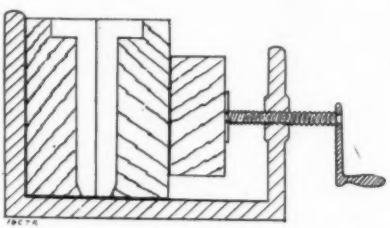

FIG. 1.—CORE BOX CLAMP.

to take, roughly, about two weeks to mould, say about £4 10s., I have seen as many as ten bed-plates ordered at one time. Yet the pattern was made of soft wood, hardly any taper, where there most certainly could have been plenty, no rounded corners, no fillets worked in, no rapping or drawing plates, and, in the broadest sense of the word, a shoddy and jerry-built pattern. Fortunately, the director came into the foundry as the top part of the mould was being lifted off, and was astonished at the moulder not getting a better lift. He sent for the foreman pattern-maker, and the whole question was thoroughly thrashed out, with the result that a new pattern was made, with all the taper possible, and every convenience for moulding. The first casting was made in a little over a week, at a cost of, say, £3 10s.—a clear saving of 20s. on each; but this did not stop there. In a very short time the moulder got well into the run of the work, and turned out one per week. This would show a saving of at least £2 on each bed-plate, which would,

and did soon, pay for the new pattern. After that, the forty shillings was clear profit.

This is well worth the consideration of our managers and employers, who, were they to come into the foundries more often and see things for themselves (and not rely upon reports of the foundry foreman or pattern-maker), would, I am sure,

FIG. 1.—ELECTRIC DRILL.

render real help to moulders, besides making the foundries much more lucrative.

Of course, I do not mean to infer that all patterns must be made of mahogany and elaborately finished.

With regard to core-boxes, very little consideration is paid to the usage they are likely to be subjected to. For instance, some have to be used for loam, then put near the fire to stiffen the loam before the core can be taken out; and if these boxes are made of soft wood, as some are, they warp, shrink, and twist into all shapes. I have never seen a box sent into the foundry with provision made for clamping them together, yet every pattern-maker knows that they must be fastened before a single core can be made in them. For large core-boxes I would suggest some sort of clasp, so that they can be readily fastened and unfastened. The cost of such clasps would soon be saved by the prolonged life of the core-box. For small core-boxes a cast-iron clamp with screw handle will be found a useful article, and entirely do away with the destructive dog now so widely used.

ELECTRICITY IN THE FOUNDRY.

WITH the almost universal adoption of electricity for lighting purposes in the foundry, machine shops, and yards of modern works, one would have expected to see a more general application of this convenient power medium to other purposes. As the lighting plant is used for a comparatively short time each day in the winter, and not at all in the summer, any use to which it could be put for reducing costs of manufacture, should, we think, be eagerly adopted. We have had an opportunity of seeing examples of this, and in our illustration, Fig. 1, we show the electric current in use for drilling. It can be advantageously applied to a host of other operations which are at present performed in a more or less old-fashioned manner. Portable boring, sawing, milling, and other machines, driven by small electric motors, save the cost of transporting large castings on to machine tools requiring more power to drive them than actually to do their work. Small electric grinding machines can be applied in a variety of ways, the grinding of castings in the fettling shop being a notable example.

FIG. 2.—ELECTRIC HOIST.

The "Boreas" electric hoist or pulley-block, illustrated, is another example. It can be hooked on to a beam or jib anywhere, and the current carried to it by a simple cable. It is then ready for quick lifting and lowering, and, as the only operation necessary is the pulling of a cord, no extra labourer is required to work it; the cost of the appliance is therefore saved in a very short time. Our illustrations are from photographs lent us by Messrs. Lacy, Hulbert & Company, Limited, of Boreas Works, Beddington, Croydon, and represent their now well-known "Boreas" electric appliances, which are being largely adopted.

CORE SAND BINDERS.*

I BELIEVE that I can show good cause for the title "Core Sand Binders"—show that these words are better, and that we should drop the use of the expression "core compound" as the general name for the materials that are used in sticking core sand together. It is true that every material used for this purpose is a compound. But so is the sand a compound. So is the pig-iron a compound, though certainly no salesman has yet had the nerve to offer you any Carnegie chill casting compound under the impression that you would recognise it as pig-iron.

The materials in question are employed solely for their adhesive qualities. You may say that they do other things, but be that as it may, the basic reason for their use is to bind the sand together so that it will take and hold the desired shape. Certainly such a material is a sand binder, and when used for cores a core sand binder. This is my plea and I hope my justification for the new name.

The Core Shop Suffering from Neglect.

It has been brought forcibly home to me again and again that the core shop has suffered and is suffering from neglect. I doubt if there are five of you who can tell what your binders cost per ton of sand mixed; not half who can tell off-hand, with any accuracy, what your core sand mixtures are, and I will warrant if there are any who think they know, that one visit to their core room will prove they are in error.

Here is a trade without a literature. Can you expect progress from a nation without a written language? In what is probably the most read book of the few relating to the foundry trade there are just 4½ pages devoted to core making out of nearly 400, and one-half of these 4½ pages is padding.

The Coremaker Difficult to Teach.

This neglect has brought about another condition of affairs. The sand, the binders, and the manner of drying have been worked out for each foundry, and the coremaker that lasted long enough to get good results has held the job until he and not the office was tired. This fact has made him narrow, localised, and with a high opinion of his own skill in sands and binders, and therefore difficult to teach.

As an example of this, and also of several other related points, I recollect meeting a coremaker a short time ago who was dissatisfied with the results he was having. This in itself was remarkable, and especially so because in my business of selling a core sand binder I had just left the office of the company he was working for, where I had been told that they could not even listen to my story because they were getting good results from their cores, and there was no use in disturbing any part of the plant that was running smoothly and well.

It turned out that this man had been working for a rival concern, located a few miles away, and because of his good results had received and accepted an offer from his present employer, who at the time was having trouble from excessive breakage of cores, much blown work and many condemned castings, owing to defects in the cored work.

Now he had used my binder in the old shop, and I was, of course, curious to know why I had lost his trade, and anxious to secure it again. I knew something of the sands in that locality, and after an examination of those he was using, I worked out the following story:—The figures that I now give are not the actual ones, but are relatively correct. The sand mixture in his old shop was:—

	s.	d.
30 per cent. old or gangway sand...	—	—
30 per cent. loamy sand, at 7s. 6d. per ton ...	2	3
40 per cent. local bank sand, at 3s. 1½d. per ton...	1	3
Total	3	6

1 part of Gluetrin to 40 parts of sand.

This binder cost 7½d. per gallon. The sand ran 900 quarts to the ton, and on these figures the binder cost 3s. 6d. per ton of sand mixed, and the total cost for each ton of core sand ready for cores was 7s. The new shop had been using:—

	s.	d.
40 per cent. sharp sand, at 5s. per ton	2	0
60 per cent. loamy sand, at 7s. 6d. per ton ...	4	6
Total	6	6

1 part flour to 12 parts sand.

Flour at that time cost £5 a ton, and on a weight of 1.1 lbs. to the quart the cost of binder per ton of core sand mixed was 4s. 4d., and the total cost for each ton of core sand ready for cores was 10s. 10d. per ton. The work from these cores was bad. They had tried rosin, on and off, with equally poor results.

With these two sands, which were different from the loamy sands of his old shop, this man tried with and without old sand, Gluetrin, as he had used it before, and failed. He then went back to the original practice of this shop—flour—

* Paper read by J. S. Robeson, president of the American Glutrose Company, Philadelphia, before the Pittsburg Foundrymen's Association.

and by changing the mixture slightly and seeing that the proportions of the sands and the sands to the flour did not vary, and forbidding the coremakers to run to the flour sack whenever they liked, which had previously been allowed, he managed to get much better results than they had formerly secured. This satisfied the office, but the work was not as good as in the old shop. He knew it, and was dissatisfied, but apparently helpless. Here was a man that looked ready for my material, and in spite of his failures was easily persuaded to try it again. I was certain after examining his sands that the whole trouble was in the sand mixture, and several were tried, this being finally adopted as the most satisfactory and economical:—

	s.	d.
40 per cent. old or gangway sand...	—	
40 per cent. loamy sand, at 7s. 6d. per ton ...	3	0
20 per cent. local bank sand, at 3s. 1d. per ton	0	7½
Total	3	7½

1 part of Gluetrin, at 7½d. a gallon, to 50 parts of sand cost 2s. 10d. per ton of sand mixed, and the total cost for each ton of core sand, ready for cores, was 6s. 5d.

This was successful, reduced the breakage of cores and did away entirely with any blown castings or trouble from the size of cored holes, besides making a clear saving of 4s. 4d. on each ton of core sand mixed.

It seems to me that there were two causes at work here. The one that his superiors did not know enough to push him for better results, nor to aid him with suggestions, and the other that he himself lacked sand experience, did not realise that even though sands look alike they may be different, and that one or two trials are not sufficient to test a sand or a binder. Incidentally he learned how to figure the cost of his mixture, something he had never done before.

Kinds of Core Sand Binders.

Under this heading of core sand binders any material possessing adhesive qualities might be included. Local conditions and sands have caused the use of some that seem absurd to the general trade. A consideration of these freaks is omitted and only those that are found in general use are considered. These are:—

Solids.	Liquids.
1. Dextrine.	1. Fish oil.
2. Flour.	2. Glue.
3. Proprietary dry mixtures.	3. Gluetrin (proprietary liquid).
4. Rosin.	4. Linseed oil.
	5. Molasses.
	6. Proprietary oil mixtures.
	7. Rosin oil.

At the first glance it is seen that these can be divided into two distinct classes—the solids and the liquids. It is to the difference in action of these two conditions of matter when used as core sand binders that I wish especially to call your attention, and not to the merits or demerits of any particular one.

Let us consider the work that is required of a binder. The local conditions in each shop vary greatly, and it is only possible to name these requirements in a general way. A good binder must make a core that (1) is strong both green and dry; (2) is weak and rotten after the casting is cooled; (3) is not easily affected by moisture; (4) will give off but little gas; (5) will dry quickly; (6) will not change in size; (7) has a low cost.

The ideally perfect core sand binder is one that mixes easily with the sand, making a mass that packs with but little work in the box, leaves it freely and leaves it clean, is strong enough before baking to stand alone without sagging or deformation, and retain sharp edges. Such a core must now bake in the shortest possible time, and when baked be hard enough to stand rough handling, be weak enough to yield to the contraction of the iron in cooling, porous enough to permit the gases to escape freely, and after cooling leave the casting easily and cleanly.

The usual method of preparing the mixture is to put on the floor the required quantity of each kind of sand, previously selected by the foreman or boss coremaker, and to spread or sprinkle on top of this pile the necessary amount of the dry or liquid binder that is to be used, afterwards wetting the mass, as may be required, with water. This pile is then cut over and shovelled, being finally put through a riddle, and then delivered to the coremakers or put in a pile ready for their use. There are various modifications of this practice in the way of riddling the sand before the binder is put on, mixing in a machine, etc. Every step that is taken to increase the thoroughness of the mixing is a step taken in advance. The more perfect the mixture the better the core.

If you are using a dry binder—flour, for example—and it is simply dumped on the pile of sand, wet down and put into barrows, wheeled to the coremaker and made up into cores, you will have a core that consists of a gob of flour with a little sand in it next to a gob of sand with a little flour in it. It does not take a very wise man to know that such a core will be weak, and it is a fair presumption that when the hot metal strikes one such loaf of bread in the core there will be a large volume of gas given off at that point and a resultant blown casting.

The more thoroughly the sand and binder are stirred and mixed together, the more even will the distribution be, and the more nearly will the ideal condition be reached of having each grain of sand surrounded and attached to the next grain by the binder. For this reason dry binders should be very finely ground—be very much finer than the sand.

This condition of fineness is true of flour, not quite so true of rosin, and not nearly so much so of the dry binder mixtures on the market. Flour is delivered in a much more finely ground condition than any particle of ordinary sand, and if kept dry will remain loose and free from lumps. Rosin is not usually—in fact, I think, never—so finely ground, but even so will immediately, because of the moisture and heat in the air under normal conditions, commence to stick together and ball up. All the dry mixtures sold will act the same way as rosin, in varying degrees, so that the result with these two latter materials is that, however much labour may be spent on the mixing, the mass will never be nearly so uniform as with flour. If flour is therefore the best, let us see how bad it is.

The sand is composed of grains varying in size from particles as small as a needle point up to $\frac{1}{4}$ in. The variation in the shape of these grains is much greater than in the size, and in fact the shapes met with are so various that they cannot be numbered. This matter of shape, as long as the size is within the limits already mentioned, is the most important. Roughly speaking, these grains may be divided into two kinds, namely, those that are angular, having sharp corners and numberless projections and recesses; and those that are rounded, the projections having been rubbed off so that the grain is a more or less true sphere with a highly polished surface.

The bond is increased in the cores by the use of some added material; that by the aid of water or of heat becomes adhesive or is so of itself. This, however, is but an aid. It does not change the conditions produced by the first shape of the sand grains. The more angular they are the less work the added adhesive has to do; the more rounded, the greater the work. There is a common expression used in the foundry that a sand is sharp, and, on examination, I have found that such a sand invariably shows the angular grains to which I have referred.

I have not come across, however, any expression or word or name that denoted the reverse of this condition—the non-sharp kind. All of the non-sharp kind that I have used contained some loam or clay; so that, for want of a better name, I have called this loamy sand. Now I do not know whether it is true or not that these rounded grains only occur with the loam admixture. It is my experience, however, that the two always appear together, and when they do so appear that the loam acts as a binder. Thus the two kinds of sand, the sharp sand and the loamy sand, are both, in a measure, self-binding, though from entirely different causes, and the bond, as formed, is of a different nature.

I have never found a case where what might be termed the angular bond was strong enough to make a core without an added binder, but I know of one loamy sand—and there are probably others—from which hard cores can be made without the addition of any adhesive.

It is easy to select two sands entirely unlike in their physical conditions and self-binding powers that are in practice bound and made into cores with the same adhesive material—flour—and requiring about the same amount. It is evident, therefore, that the binding power of the angles on the sharp sand is replaced by the adhesive property of the loam in the loamy sand.

Results of Using these Sands.

From this view of the situation it would seem that it made no difference which sand was used, that the one was as good as the other. There is, however, a very great difference in the structure of the two cores. With the sharp sand the angles fit into one another, but not perfectly. The flour particles press into the recesses, rest on the projections and lie against the body of the grain, but not flatly, completely, perfectly; the very irregularity of the shape making the joint between the grains of sand themselves, as well as with the binder, imperfect, and as a consequence the mass is not solid nor compact, but consists of grains tightly and perfectly joined at different points to the surrounding grains, but with open and unjointed parts at other points. In other words, the interstices are not completely filled. Thus the core is porous, though strong, with ample opportunity for the travel through its interior and out to the surface of any gases that may be generated.

With the loamy sand the story is different. Here the binding is entirely dependent upon the adhesive strength of the loam and the flour. With the addition of water, these two mix intimately and easily, and as the rounded and polished surfaces of the sand grains come together under the pressure of the ramming this

fluid mass of adhesive—greater in proportion to the whole mass than with the sharp sand, you must remember—is forced and flows into the open space between these grains, a much smaller space than with the angular sand, and as a consequence these inter-grain spaces that would form passages for the travel of the gases are almost closed up. In other words, the interstices are almost completely filled. Thus the core is strong, with the same amount of flour is actually stronger than when made from sharp sand, but very dense and compact.

As a proof of this you will find that the man who is using sharp sand as his base for cores seldom or never talks about trouble from his cores blowing. He cares little whether the core and binder offered him has gas in it or not, but the man using the loamy sand is ever on the watch for that point. He knows that he must be careful, and because flour gives off so much smoke and gas when the hot metal strikes it he is ever seeking for a substitute that will give him less trouble and reduce his lose from core-blown castings.

Solid and Liquid Binders.

Now it has been noted that the binders commonly used can be divided into two classes, the solids and the liquids, and also that, in preparing the core sand mass, water is invariably added. With the exception of the rosin all of these dry binders are more or less soluble in water. The rosin, after it has been mixed and moulded, likewise becomes liquefied or partly so, because of the heat in the core oven.

At the first glance it would seem then that they all became liquids during the operation, and that there is thus really but one class of binders. This is not entirely correct, because, first, some of the mixing is usually done before the water is added; and, second, because only enough water can be added to make the mass properly damp for ramming. This amount is not sufficient to make the dry binder thin, fluid, and in a condition to run freely through the sand. The most casual examination of a rosin-made core will show that the sand and binder are very improperly mixed. The rosin can be seen in spots throughout the mass, and it is, as a fact, the poorest, and, per unit of volume, the most expensive of the binders, mainly because of the impossibility of proper mixing. This but goes to prove the well-known fact that a more uniform mixture can be attained when a liquid and a solid are put together than when two solids are used. The thinner the liquid the more easily will it run through the mass of sand, and the more rapidly and completely will it cover each grain.

It would, therefore, seem that a liquid binder would, with the least work, give the most perfect mixture, provided, of course, that it was thin enough when put on the sand to flow freely through it. It must also be sufficiently adhesive per unit of bulk so that the amount added will not make the sand too damp. Some experiments recently made for the purpose of proving this theory showed that the efficiency of all of the dry binders could be increased by better mixing, but that the expense of so doing was greater than the cost of the binder that was saved, as, aside from the difference between hand and machine mixing, this means simply longer continued work on the sand mass.

With the liquid binders a somewhat different method seemed possible. Having the idea in mind that the thinner the binder the better the mixture, a material was selected—Gluetrin—that mixed easily and readily with water, and a test was then made by putting this on the sand in the form of a spray with compressed air. At the foundry where this was tried their regular core sand mixture was :—

	s.	d.
20 per cent. old or gangway sand	—	
60 per cent. gravel, at 5s. 10d. per ton	3	6
20 per cent. local sharp sand, at 3s. 9d. per ton	0	9
Total	4	3

1 part Gluetrin mixed with 1 part of water to each 50 parts of sand.

This sand ran 930 quarts to the ton, and the binder, therefore, at 7½d. a gallon, cost 2s. 11d. per ton of sand mixed, and the total cost for each ton of core sand, ready for cores, was 7s. 2d. The practice was to put the sand on the floor in three layers as dumped from the wheelbarrows. This was then shovelled and cut over about three times while dry.

The Gluetrin had previously been mixed with an equal amount of water, and was then sprinkled over the bed of sand from a watering pot. The pile was shovelled over once, sprinkled with water, and put through a riddle on a pneumatic shaker and taken to the coremakers. In the first test with the compressed air spraying, the same amount of Gluetrin and water was used, and the cores were entirely too hard.

Various trials were made until now their practice is to wheel in the sand and put it on the floor, as formerly, but as the sand is shovelled and cut over, while dry, it is thrown rather high from the shovels, and is met by a spray of Gluetrin and water. This is done twice, and it is then

put through the riddle as before. The sand mixture is now :—

	s.	d.
40 per cent. old or gangway sand	—	
40 per cent. gravel, at 5s. 10d. per ton	2	4
20 per cent. local sharp sand, at 3s. 9d. per ton	0	9
Total	3	1

1 part of Gluetrin, mixed with two parts of water, to 70 parts of sand. Thus the binder costs but 2s. 1d. per ton of sand mixed, and a total cost of 5s. 2d., as compared to 7s. 2d., a saving of 2s. per ton.

Here is a credit for old sand, binder, and labour, due to the method of mixing alone, and a small debit for compressed air.

As the oils and oil mixtures are too expensive per unit of volume for general use, and this without regard to their merits or faults in any other respect, but few tests were made with them. Such as were made, however, agreed with this result.

COMPANY NEWS.

Pease & Partners, Limited.—The directors have resolved to pass the interim dividend.

Warner & Company, Limited.—Interim dividend of 8 per cent. per annum for the half-year.

Sheepbridge Coal and Iron Company, Limited.—Interim dividend of 5 per cent. per annum.

Measures Brothers, Limited.—Dividend of 3½ per cent. for the year, carrying forward £199.

John Spencer & Sons, Limited.—Interim dividend for the half-year of £5 per cent. per annum.

William Jessop & Sons, Limited.—Dividend, 7½ per cent. for the year ending December 31, 1904.

Bolckow, Vaughan & Company, Limited.—Interim dividend for the half-year of 5 per cent. per annum.

Mather & Platt, Limited.—Interim dividend on the ordinary shares of 6 per cent. per annum for the half-year.

South Durham Steel and Iron Company, Limited.—Annual profit of £80,095; depreciation, £35,000; carry forward, £3,444.

Workington Hematite Iron Company, Limited.—Interim dividend of 6d. per share (2½ per cent.) on the ordinary shares.

Wigan Coal and Iron Company, Limited.—Annual profit, £67,036. Dividend of 4 per cent. per annum; £17,999 carried forward.

PIG-IRONS AND THEIR USE IN THE FOUNDRY AND FORGE.*

Introductory.

It may be well to briefly describe what pig-iron appears to be through different glasses. The acid steel manufacturer views pig-iron from its freedom from such impurities as cannot be eliminated by the acid process, whilst phosphorus—to him one of the greatest impurities—is in the basic-Bessemer process an absolute necessity, and in the basic-Siemens' process also useful—the only common interest on any vital point being the united enmity against sulphur. The malleable cast-iron-founder, whose castings may be called half-way to steel—whilst not being semi-steel—can, by virtue of his special treatment, use pig-iron which is of no use to the steel manufacturer, and not of much use to the foundry or forge. The wrought-iron manufacturer requires a pig-iron which in grade comes between those used for malleable castings and ordinary foundry irons, and to the manufacturer of ordinary iron castings pig or cast iron is a material of so widely different properties that its study, from point of view of fracture, and from point of view of chemical composition, amounts nowadays, to almost a fine art. It is for the two latter that this paper is more particularly written, and to manufacturers faced with such a variety of specifications for their finished goods, pig-iron and its contents—graphitic carbon, amorphous graphitic carbon, combined carbon, silicon, sulphur, phosphorus, manganese, and sometimes copper, arsenic, and titanium, the total impurities being anything from 4.00 per cent. to 10.00 per cent.—presents an unfailing subject of instructive and interesting study, which the relentless march of scientific investigation renders imperative if the finished goods are to hold their own in the world's markets in quality and in price.

The following table gives the source of the ore supply of each district, showing how some districts are now so much dependent upon others for their ore supply :—

Table A.

District.	Ore Supply.
Scotch Pig...	Scotland—largely the Blackband and Clayband ores, which are very similar in character to those formerly, and to a small extent still, found in Staffordshire.

* Abstract of paper read before the Manchester Association of Engineers.

District.	Ore Supply.
Cleveland or Yorkshire Pig ...	Cleveland Hills of North-East Yorkshire. These are known in market reports as "G.M.B.'s."
Lincolnshire Pig ...	Lincolnshire — chiefly in the Frodingham district. Several *West* Yorkshire brands of pig come under this head.
Derbyshire Pig ...	Formerly Derbyshire ore, but as the deposits have nearly given out, ores from Northampton, Leicester, Nottingham, and Rutland are now largely used, as well as part Lincolnshire.
Nottingham Pig ...	Many of these are classed with Derbyshire irons, and draw their ore supply from similar sources, *i.e.*, chiefly the South Midlands.
Northampton Pig ...	Rutland, Northampton, and Oxfordshire.
Staffordshire Pig (hot blast) ...	Hot blast irons were formerly made from local ores, but as few of these ores are now available, most of the ore supply is obtained from Leicester. Northampton, and Oxfordshire.
Do. (cold blast)	Cold blast irons are largely made from local ores, but hematite ores low in phosphorus are to some extent used.
Yorkshire Cold Blast Pig ...	There is practically no Yorkshire cold blast pig on the market, as those firms who make it use nearly all they can produce for best Yorkshire wrought iron. The ore supply is local.
Refined Pigs	These are not "virgin" irons, that is, made direct from ore, but are selected pig-irons which undergo special treatment.

Hematite Pig-Iron.

The above described irons come under the heading of foundry and forge pigs, but in addition to these there are hematites which, whilst chiefly used for the production of steel, enter more or less into the manufacture of many classes of the better qualities of iron castings. This iron can be divided into three classes, (1) made from foreign ores, (2) made from local ores, and (3) from part local and part foreign.

It may be well to remark here that the chief difference between local and foreign ores is that the latter contain small percentages of copper and sometimes traces of arsenic, whilst the former are free from such impurities. Foreign ores also contain manganese, whilst the local ores are fairly free therefrom. In one way, manganese is not considered to be an impurity, as it can be controlled in the manufacture of steel, and in cast-iron it is, in small proportions, beneficial rather than otherwise. Steelmakers would also not consider copper and arsenic as objectionable, except where their specifications provide for a maximum given quantity, so that in the foundry and forge they may safely be left out of consideration, as up to the present they have not entered the cast-iron specifications.

Titanium is recognised as being beneficial in iron, but it is more in connection with chilled work.

Typical Analysis.

The chief difference between ordinary foundry pig-irons and hematites is phosphorus, as will be seen from a study of the following typical analyses :—Table B, showing hematites; and Table C, ordinary foundry and forge.

TABLE B.—Hematite Irons.

(1) West Coast Hematites.

	G.C.	C.C.	Si.	S.	P.	Mn.	Mn.	Cu.
No. 1	3·750	·300	2·60	·02	·045	trace	1·00	·04
,, 2	3·500	·460	2·40	·03	·045	do.	1·00	·04
,, 3	3·250	·540	2·10	·04	·045	do.	1·00	·04
,, 4	2·800	1·000	1·65	·10	·045	do.	1·00	·04
,, 5	2·400	1·600	1·20	·20	·045	do.	1·00	·04
Mottled	1·600	1·950	·90	·25	·045	do.	·75	·04
White	trace	3·250	·65	·30	·045	do.	·50	·04

From Native Ores only. — Average actual Mn. and Cu.

Special	3·75	·300	2·60	·02	·02	1·500	
	3·75	·300	2·60	·02	·025	1·500	

(2) East Coast Hematites. West Hartlepool. Seaton Carew Iron Co., Ltd., Seaton Brand, "Seaton."

	G.C.	C.C.	Si.	S.	P.	Mn.	Cu.
No. 1	3·735	·300	2·50	·02	·05	1·00	·05
,, 2	3·525	·450	2·25	·03	·05	1·00	·05
,, 3	3·150	·560	2·00	·04	·05	1·00	·05
,, 4	2·750	1·000	1·50	·10	·05	1·00	·05
,, 5	2·450	1·550	1·00	·20	·05	·75	·05
Mottled	1·500	2·050	·75	·25	·05	·50	·05
White	trace	3·150	·65	·30	·05	·50	·05
Special No. 1	3·525	·300	2·50	·015	·03	1·00	·05
,, 2	3·350	·400	2·25	·020	·03	1·00	·05
,, 3	3·000	·500	2·00	·025	·03	1·00	·05

(3) Scotch Hematites.
(4) Welsh Hematites.

These are practically of the same composition as the East Coast Ordinary Hematites. There are no Special Hematites made.

Quality.

In the earlier days of pig-iron, when furnaces were built near the ore mines of each district, there was a much greater

difference in the analyses than at the present time, when one district has to draw upon another. The chief difference was then, and is now, one of phosphorus and manganese, for with these elements, "if the devil goes into the blast furnace, the devil comes out."

As to methods of manufacture, it may suffice to give only one illustration. Some

TABLE C.—Foundry and Forge Irons.

(5) Scotch Pig Iron. Carron Iron Co., Glasgow. Brand. "Carron."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3·500	·140	2·800	·035	·880	1·450
,, 2	3·370	·250	2·275	·045	·907	1·450
,, 3 Soft	3·280	·180	2·650	·038	·902	1·400
,, 3 Foundry	3·350	·200	2·150	·055	·907	1·311
,, 3 Close	3·170	·280	1·750	·050	·905	1·420
,, 4	3·160	·290	1·570	·060	·905	1·450

(6) Yorkshire Pig Iron. The Carlton Iron Co., Ltd., Carlton Ironworks, via Farrphill. Brand. "Carlton."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3·290	·057	3·190	·038	1·290	·330
,, 3	3·240	·110	2·770	·030	1·360	·250
,, 4 Foundry	3·190	·164	2·330	·035	1·320	·320
,, 4 Forge	2·030	·363	2·120	·024	1·180	·250
Mottled	2·030	1·250	1·790	·130	1·450	·320
White	·120	3·100	·880	·240	1·400	·380
Glazy	3·060	·020	5·120	·010	1·000	·250

(7) Lincolnshire Pig Iron. Redbourne Hill Iron and Coal Co., Ltd., Doncaster. Brand. "Redbourne."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 3 Foundry	3·100	·360	2·751	·038	1·326	1·660
,, 4 Foundry	2·816	·751	2·610	·045	1·316	1·589
Grey Forge	2·525	·895	2·508	·056	1·316	1·456
No. 4 Close	2·459	·945	2·452	·059	1·296	1·544
Mottled	1·490	1·520	1·325	·100	1·296	1·130
White	·675	2·285	·450	·135	1·295	1·100

(8) Derbyshire Pig Iron. Renishaw Iron Co., Ltd., Eckington. Brand. "Renishaw."

	G.C.	C.C.	Si.	S.	P.	Mn
No. 1	3·410	trace	2·939	·036	1·680	·362
,, 2	3·265	·179	2·145	·084	1·623	·707
,, 3	3·450	·112	2·333	·094	1·561	·572
,, 4 Foundry	3·300	·225	2·099	·053	1·771	·647
Close Forge	2·800	·330	1·819	·079	1·730	·520
Mottled	1·550	1·560	1·200	·200	1·500	·350
White	2·850	·100	·450	·250	1·350	·350
Glazy	3·450	trace	4·500	·070	1·600	·610

(9) Nottingham, Northampton, and Iron Co., Ltd., Ashford. District Pig Irons. Brand, "Holwell." Holwell

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry	3·850	..	2·612	·022	1·190	·490
,, 2 ,,	3·650	..	2·473	·036	1·178	·402
,, 3 ,,	3·850	..	2·379	·041	1·190	·403
,, 4 ,,	3·350	..	2·332	·047	1·355	·389
,, 4 Forge	2·971	..	2·331	·056	1·098	·484
,, 5 ,,	1·750	..	1·876	·069	·929	·245
Mottled	1·540	..	1·361	·235	·970	·217
White	·940	..	1·049	·305	·937	·188
Glazy	2·500	..	4·840	·028	1·285	·532

(10) Staffordshire Special Hot Blast Iron. The Lilleshall Co., Ltd., Priors Lee Hall, near Shifnal, Salop.

	G.C.	C.C	Si.	S.	P.	Mn.
No. 1	3·05	·22	3·00	·01	·61	1·10
,, 2	2·95	·23	2·81	·02	·66	1·13
Mixing	3·05	·27	2·20	·03	·64	
,, 3	2·83	·34	2·27	·05	·64	
,, 4	2·61	·44	2·20	·06	·65	
,, 5	2·50	·57	1·71	·07	·65	

of the small Swedish blast furnaces make perhaps only 50 tons of iron per week—many of the English furnaces to-day make only 300 tons—whilst the latest type in use in England, having mechanical charging appliances, etc., have a capacity of 1,500 to 2,000 tons, and in the United States there are furnaces which are supposed to produce 6,000 tons per week. From the point of view of the quality of foundry and forge pig-iron for tests, may the time be far distant when this last type of furnace is introduced into this country, as one is led to ask is such a furnace under control in the smallest degree—the temperature of blast, etc., may be, but not the mixing conditions going on in the inside of the furnace. This question of control is not a difficult one to understand, and is one of the principal reasons of regularity of Swedish products, this uniformness being the chief difference between these and the English irons, but suitably refined irons, which are also made in small quantities, should be quite as good as those produced in Sweden, analyses for analyses.

Herein lies a prejudice, which is that Swedish pig-iron is much superior to English for all purposes. The difference is one of a "mechanical" nature, and is fully referred to later in this paper; but, in the writer's opinion, it applies only to the average run of English irons, as irons originally made in a large blast furnace, with coke as fuel, have given some of the highest recorded tensile and transverse tests. To some who have been accustomed to use high-priced foreign pig-irons for foundry and forge, as well as steel, this is perhaps a sweeping assertion to make, that so long as similar irons can be obtained in this country, which they can, there is no need to import foreign pig-iron.

Grading.

In both the foundry and forge the question of grading is most important. In this country it is customary to grade pig-iron by its fracture and call it Nos. 1, 2, 3, 4, 5, soft mottled, hard mottled, white, and "glazy," whilst in the United States grading is by silicon contents chiefly, absolutely regardless of fracture which does not show true in the chill cast pigs as used there. Many of the coast firms are dropping No. 2 as a grade and calling all open iron No. 1, as there is so comparatively little difference between the fracture of these numbers, rates of cooling frequently deciding the fracture. Very little can be said of grading by fracture, as there are so many variations. It is possible to have an iron almost No. 1 by fracture and No. 5 by silicon analysis, whilst, on the other hand, it is possible to have an iron No. 4 by fracture and No. 1 by silicon analysis. Perhaps one of the best illustrations of this deception are some experiments by T. D. West, given before the American Iron Foundrymen's Association, of which the following Table E, is an extract :—

TABLE E.—West's Tests.

ANALYSES.

(A) Pig	Silicon	1·25	Sulphur	·035	Fracture open No. 1.
Casting	,,	1·15	,,	·070	
(B) Pig	,,	2·95	,,	·040	Fracture close No. 3.
Casting	,,	2·67	,,	·060	

TESTS.

No.	Transverse Bar.	Deflection.		Strength in lbs.	
		A	B	A	B
1	½ × 1½	·29	·35	110	164
2	½ × 1½	·25	·03	320	344
3	½ × 1½	·21	·24	550	530
4	½ × 1½	·18	·18	850	920
5	½ × 1½	·15	·14	1·280	1·236
6	½ × 1½	·14	·12	1·600	1·640
7	½ × 1½	·12	·11	2·240	2·320
8	1 × 1½	·10	·10	2·900	2·860
9	1½ × 1½	·08	·10	3·600	3·500

It will be noticed that "A" pig is No. 1 by fracture and No. 4 or nearer a No. 5 by analyses, whilst "B" is a No. 3 by fracture and a good No. 1 by analyses, and judging from this (or silicon content) the transverse test should have been widely different, whereas they are almost identical, showing there is another condition of pig-iron, already referred to, in addition to the chemical. To have this state of things existing the user naturally asks, which is the best way of judging, and before this question can be satisfactorily answered it must be decided whether pig-iron is dependent upon any other condition outside of chemical analyses.

Professor Turner has done much in this country to advance the theory that silicon is the governing element of cast-iron, and his results of tests, as comparative results, are worthy of note. From the point of view of the foundry in particular, and to a lesser extent the forge, silicon is undoubtedly the most ready method of deciding the grade of pig-iron.

As the silicon increases so the iron becomes grey, and, speaking broadly, more open, up to 3.00 to 4.00 silicon, which seems to be the saturation point of grey pig-iron and silicon—the exact percentage being as a matter of fact controlled by the other conditions, varying analyses and possibly slight variation in the methods used in manufacture. Above this percentage, the higher the silicon the whiter the iron, which in this country is then called "glazy" iron, and in America it rejoices in the more euphonious designation of "silvery" iron.

Now, if there were no scrap to be taken into consideration in the ironfoundry, there would be less need of Nos. 1 and 2 iron (by analyses), except perhaps where heat is required to make the iron run well. Silicon imparts heat and enables the metal to remain longer in a molten condition, hence an iron containing high silicon is best for very light work, and also where the casting requires to be "fed." The Americans use large quantities of glazy or silvery iron, and also ferro-silicon, to meet these requirements, which ironfounders there call a "softener."

Speaking broadly, for general castings without tests, which mostly run about silicon 2.00, which is equivalent to an average No. 3 iron, grading by silicon is the simplest way of working, but if all ironfounders insisted on analyses within very fine limits, and the forge also on one particular grade, the ironmaster would have a still less happy time than now, as to a very large extent he has to take what his furnace gives. Usually in the smaller English furnaces there are at least two grades or numbers, by fracture, in each cast, and occasionally when a furnace has been working badly several grades of iron from a No. 2 to a white iron by analyses and also fracture have been given in one cast—that is from silicon 2.20 per cent. to .60 per cent.

However, a judicious mixing of foundry irons of varying silicon contents, whether of the same or different brands, will give the founder satisfactory results for all general work where no special tests are desired, and for such ordinary castings no notice need be taken of any condition of iron outside of analyses. For instance, it is well known that a No. 1 iron by fracture will carry more scrap than No. 2, and still more than No. 3—the chief reason being that No. 1 has a higher silicon content. When, however, a pig is still higher in silicon than a No. 1, that is, when it contains over 3.00 per cent. to 4.00 per cent., the higher the silicon the less specular or the whiter the fracture, but not of the same crystalline character as a true white iron, the fracture of which, however, it often somewhat resembles, so much so that many ironfounders are afraid to use it. This is the fracture called "glazed" or "silvery" iron, but it is not possible to give a definite minimum silcon content which would determine this, as some irons are "glazy" just over 3.00 per cent. and others not until the silicon is over 4.00 per cent.

At one company's furnace, the writer's attention was called to a close No. 5 fracture, the silicon of which was over 3.50. This fracture the average layman would have at once classed as a close No. 5, that is, nearly white; but it was actually at the other extreme, that is, just caught on the change point between a very open No. 1 iron and a "glazy" iron. The following curves A and B in Fig. 1 will illustrate this change point. These curves in silicon contents and fracture are taken as what

they are theoretically, and what they have usually been in this country. As already explained, however, the altered conditions of working does not always follow the old practice in the ratio of silicon to fracture, hence these curves must be taken as approximate in these ratios, and are more to show that between true white iron and the most open, by fracture, there are a large number of changes in fractures, but between the most open and a further increase in silicon, bringing the white or glazy white fracture, the change is very sudden.

In other words, with silicon .50, iron is white between that and say 1.00 per cent. mottled, at 1.00 per cent. general grey, and it goes through many grey stages until it has reached its maximum greyness, but once having reached its utmost open fracture, it very quickly goes from that to whiter or now glazy iron, which is the other extreme of the true white iron of, say, silicon .50. Curve A is of iron which turns glazy just over silicon 3.00 per cent., and curve B that of which reaches over silicon 4.00 before it turns glazy.

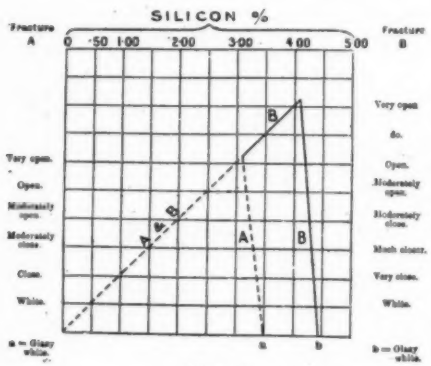

FIG. 1.

There is no need for fear by the iron-founder in the use of glazy iron, as it is a matter of simple arithmetical calculation in silicon contents as to what quantity can safely be used in any given charge; in fact, "glazed" and white iron could be melted together in some cases, and make a very passable casting for common work. This, however, is not desirable in actual practice in cupola work, because of the difference in the specific gravity of the two irons, for, unless they are thoroughly mixed, there may be two classes of metal in the one ladle, for the density of the white iron would carry it to the bottom, and the lighter iron would remain at the top. Then there is the deadly enemy sulphur, which in white iron sometimes is as high as .40, or four times a reasonable maximum for castings. As a contrast to our methods of grading by fracture, there is given in Table F a specimen of the American method of grading by analyses. This is of charcoal iron, but silicon content generally runs lower in ordinary numbers in America than in this country.

TABLE F.—*Example of Grading in the United States.*

Charcoal Cold Blast Pig Iron.

GRADE.	SILICON.	CHILL TEST OF PIG.
No. 1 A	2.0 to 2.30	
,, 1 B	1.75 ,, 2.00	
,, 1 C	1. 0 ,, 1.75	
,, 1 D	1.25 ,, 1 50	
,, 2 Soft	1.00 ,, 1.25	
,, 2 Hard	.75 ,, 1.00	
,, 3 Soft	.55 ,, .75	¼ in. to ⅜ in.
,, 3 Hard	.40 ,, .55	½ ,, ¼ ,,
,, 4 Soft	.30 ,, .40	¾ ,, 1¼ ,,
,, 4 Hard	.20 ,, .30	1¼ ,, 2 ,,
,, 5	.10 ,, .20	Mottled.
,, 6	.00 ,, .10	White.
Phosphorus	.150 to .220	
Manganese	.399 to .700	
Sulphur	trace to .018	

Special Castings.

The foregoing remarks apply to the general run of heavy castings and ordinary wrought iron, of which there is perhaps a greater total weight than in any other class of similar materials, but in dealing with special castings to meet mechanical tests, other conditions have also to be considered. Were it only the question of different analyses, this would still come under the heading of grading by analysis, but there is undoubtedly a "mechanical" condition of pig or cast-iron as well as a chemical, each being independent of the other. This condition is governed by methods of manufacture, and once pig or cast-iron has lost its mechanical properties—if it ever had them to commence with—experience shows it is not seemingly easy to regain them by ordinary natural means.

The writer has seen pig of almost identical analyses, when run into test bars, give, the one 41 cwts., the other 21 cwts., transverse, on a 2 × 1 bar with 3 ft. centres, and although the tests of T. D. West, already quoted, are from pits of totally different silicon contents, otherwise similar pigs, which should have given very different results, these are practically identical, showing distinctly another condition of pig-iron independent of chemical.

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THE MOXLEY IRON WORKS, near Bilston, lately carried on by Messrs. Nock & Summers, have been sold to Mr. J. Baker, of Bilston. The plant is being dismantled.

MELTING AND COOLING OF IRON.

MR. R. BUCHANAN, of Birmingham, President of the British Foundrymen's Association, gave on Friday, February 24, an interesting lecture to the Coventry Engineering Society, his subject being "The Melting and Cooling of Iron." Mr. J. Millburn presided.

Mr. Buchanan said it was daily becoming a greater necessity that there should be accurate knowledge of how to mix cast iron for the particular work the foundryman had to do, and that they should also be able to picture to themselves in some degree how and in what manner the desired end was attained. They should work with knowledge and intelligence, and not simply according to rule of thumb or tradition. He was glad the purchase of iron by analysis was growing, which meant that more accurate and reliable methods of purchase were being adopted, with, no doubt, due reward to those who knew what to ask for suited to their requirements. It was unfortunate that blast furnacemen and merchants, in many cases, seemed to consider definite analysis of pig-irons as unnecessary and uncalled for, seeing that their statements and in some cases their reputation for quality had to be relied upon. It did not require much argumentative power to show that if the irons and the reputation of the irons were all they were said to be, then confirmation of quality by analysis could only add to the satisfaction of the makers. He hoped that at latest by the middle of the twentieth century the obituary notice would have been written of the last ironfounder who bought iron by fracture.

They were thus brought face to face with the fact that to produce definite results in the casting they must possess definite knowledge of the component irons, and in some considerable degree know what was going on from the moment the mixture was made on paper until the casting was delivered to the customer, and from him into the ranks of productive machinery. He proceeded to give descriptions and illustrations of methods of mixing irons, and by means of microphotographs showed the result obtained by means of different percentages of phosphorus, silicon, and manganese.

After briefly describing the physical process of melting in the cupola, he said that in melting sulphide of iron, phosphide of iron, and the silicon compounds they melted in the order named. As manganese and carbon were isomorphous they probably dissolved into iron at the same temperature and at the same time. With regard to the carbon which was in the iron charged into the cupola, some of it was combined carbon dissolved in the iron and combined with it. That it should remain so was what might be expected, at least during the time the iron was in the molten state. When iron and carbon were melted together, free from the presence of other bodies, the carbon was always in the combined form, unless under very special conditions of cooling. Graphite also became dissolved in the iron as combined carbon and absorbed heat in becoming dissolved. This heat was given out when graphite was expelled in cooling. All the carbon was in solution in the iron so long as it was in a molten condition. The effect of chilling was to fix the carbon dissolved in it, and some of this carbon being liberated during the pouring of a casting caused annoyance and loss in finished work. Hot iron naturally kept dissolved an amount of gas and dissolved materials which it was unable to retain when cooler.

Many foundries cast almost all their work without feeding the castings. This was only possible with soft weak irons and with scantlings very regular indeed. Strong irons would always want more feeding than soft ones. He would say that for strong close-grained castings, iron with fairly low total carbon was required, so that no kish or carbon might crystallise and separate in the course of handling and pouring the metal. It was a debatable point whether castings for best finish should be poured as hot as the metal may be had, or whether it should be kept until it had cooled somewhat, though still very much hotter than what was called "dull" iron. Discussing the reason for either procedure he said that when a casting was run with metal hot as it came from the cupola, the high temperature of the iron was apt to make rough castings unless the mould be in dry-sand or loam. Hot metal might cause erosion of a mould, but he did not think it caused "scabbing" so readily as would "dull" iron. Hot iron, however, allowed segregation to take place more readily than duller iron would. Hot iron more readily held the gases in solution and continued to do so under the pressure of the runner head until solidification took place. That was, of course, an advantage. Another advantage was that should there be any gas generated in the mould and no free passage for it through the mould; hot metal allowed the gas to pass up through it, with only temporary ebulli-

tion. That was only possible or agreeable when the gas was of very limited quantity. If the gas were of unlimited quantity, and no outlet for it through the mould, then it came through the metal, whether it be hot or dull, and a great deal of the metal came with it, causing what was tersely described as a "blow-up." Hot metal, if not fed more easily, sank or drew locally at heavy parts.

In cooling from a hot melting temperature, say, 1,400 degrees C. to 1,350 degrees C., a fall of 50 degrees C., previous to the iron being poured into the mould, he asked them to consider what was then taking place. He explained that any contained slag and oxide had an opportunity to rise to the surface of the metal, these being of less specific gravity than the metal. The manganese also had time and opportunity to combine with sulphur as manganese sulphide. This body, Stead said, had no hardening effect when contained in the iron. Metal at a fair casting temperature causes less erosion of the mould, though erosion might practically be neglected when dealing with dry-sand and loam moulds. There was also, he believed, less segregation in the casting than when the metal was hot, but that was a very doubtful advantage. A casting cast hot took more feeding than one cast at a "fair" casting temperature. A casting cast "dull" took less feeding still. He would summarise the position of the advocates of hot and fair casting temperatures as follows:—(A) For finished castings made in dry-sand or loam, and especially if test-bars are attached to the casting, cast hot as the metal comes from the cupola. It probably will then conform to Longmuir's "Fair casting temperature." Keep the test-bars as far away from the casting as possible, to allow the bars to cool quickly. (B) When green-sand moulds were used for castings to be finished and machined all over, then roughness of skin was not important, and the mould might be cast with hot iron. Roughness of skin was very often associated in one's mind with dirty metal under the skin, but it need not necessarily be so. In fact, much of the dirt found in finishing castings was due to excess carbon in the metal and in the moulds, especially green-sand moulds. (C) He advanced it as a probability that the reason castings cast dull were weak was this, sulphide and phosphide of iron surround the crystals of iron and are in close proximity to them, and remain so owing to the rapid setting of the metal. Were the metal hot the phosphide and sulphide would be segregated and so do less harm.

Dealing with the condition of molten iron in the ladle, he remarked that it was easy to observe that vigorous changes were taking place. With 1 per cent. and over of phosphorus a cloud or thin skin of oxide and kish soon gathered on the top, and under this movements impossible to describe were taking place. Although 1 per cent. of phosphorus be present this cloud on the top of the iron did not gather if over 5 per cent. of manganese be in the iron. This percentage and over of manganese had the effect of breaking up the oxide on the top of the metal, and instead of a cloudy appearance a most beautiful series of changes of figures of an elliptic form were seen. As silicon increased the ellipses got less in size. As silicon decreased the ellipses increased in size, so moulders who were used to working with manganiferous iron judged the hardness or softness, *i.e.*, whether low or high silicon, by the size of the ellipses, or break of the metal. These ellipses were probably due to oxidation of manganese. Describing the condition cast iron was in when melted, he said it might be considered to be a solution of carbon in iron: that was, the carbon was dissolved in the iron just as salt might be dissolved in water. Manganese was also dissolved in the iron, as manganese and carbon were isomorphous: that was, they crystallised in the same way, and, indeed, combined with iron in almost exactly similar proportions. It also increased the total carbon. Silicon was also dissolved in the iron, and would dissolve in all percentages, but when it reached 4 per cent. and over it pushed out and lowered the total quantity of carbon. Certainly up to 2 per cent. silicon did not have this effect of lowering the amount of total carbon, though it affected very materially the condition of the carbon, whether it was to be graphite carbon or combined carbon when cooling was taking place. Silicon had a more powerful effect in lowering the total carbon than what manganese had in increasing the same. Silicon was probably combined with the iron in the form of silicides such as Fe_3Si. Phosphorus was combined with the necessary percentage of iron as Fe_3P or phosphide of iron. He might remark that most practical men had difficulty in really grasping the fact that phosphorus was present in molten iron and yet unconsumed. The phosphorus was not present as free phosphorus, if it were it would certainly be miraculous that an element so inflammable as phosphorus did not burn in molten iron. The reason it did not burn in the iron was simply that it was already in combination

with iron, and so no further combination can take place. The phosphorus was combined with iron as phosphide of iron, and this phosphide was dissolved in the iron. Sulphur was also present in the form of sulphide of iron, and had a most potent effect on the hardness of castings, as 0.14 per cent. made the castings too hard to machine. No doubt the sulphide had a direct hardening effect as well as through the carbon.

In conclusion, Mr. Buchanan dealt with the setting of cast iron, and explained that an expansion took place just about the time it solidified, in some irons immediately before solidification. It was the separation of the graphite which caused the expansion, and was a question of saturation. As Stead pointed out, this crystallisation of the graphite elbowed out and pushed from it the lower melting eutectic mixtures such as the phosphide and sulphide of iron. Unless under very special conditions, graphite would not separate unless silicon was present. Stead showed that flakes of graphite were always large when phosphorus was present in quantity. This seemed to indicate that the presence of fluid phosphide of iron allowed the graphite to more readily leave its combination with the iron. Iron containing 2 per cent. of phosphorus when cast into a solid block weighing 1 cwt. showed no signs of shrinkage. He had seen it explained that to expansion was due the filling of a mould in every corner and crevice when the metal was run into it. This would be nice were it true, and were it so they would not have blown holes or spongy places in castings. The supposed filling of a mould by expansion was quite erroneous. If a mould was not filled in every corner before the various expansions took place, then it was not going to be filled at all. Moulds were filled by fluid pressure, the runner-head being the reservoir from which the pressure proceeded. The lecturer showed and explained an example of Keep's cooling curves demonstrating three expansions the combined carbon at each expansion being respectively 0.60 per cent., 0.45 per cent., and 0.06 per cent.

Mr. Buchanan, answering a number of questions, said foundrymen often got a great deal of phosphorus when perhaps they did not want it, and it really boiled down. He calculated that if iron was wanted with lesser quantities of phosphorus it would cost something like 2s. for every reduction of 1 per cent. of phosphorus. They always got more phosphorus than anything the furnaceman or merchant guaranteed he was going to give them for their money. As one gentleman had said to him: "I cannot get away from phosphorus, it haunts me everywhere." The difficulty was not in getting phosphorus in, but in getting it low, and that resolved itself into a question of £ s. d. The iron in the Midlands, with 1 per cent. and over, and the irons between 1 per cent. and .06 per cent. were very few in number, and so if they wanted low phosphorus in their castings they had to practically fall back upon mixtures with hematite to get the phosphorus down. So far as he knew .4 did not do any harm. For light castings they must have phosphorus or the iron would not run well. If they had a mixture with 0.5 per cent. they would find difficulty in running their castings, but a little under 1 per cent. they got running quality combined with strength. The commercial man had to run his castings with the most phosphorus they would carry without bringing in the drawback of breakages, and each man must judge for himself how much phosphorus he could use. The more phosphorus that could be used the cheaper the work could be produced, but where quality was the supreme consideration they must do with as little phosphorus as possible. Phosphorus was the only element which was pretty well constant in melting.

A hearty vote of thanks was passed to Mr. Buchanan.

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OBITUARY.

MR. W. C. WATSON, for many years shipyard manager of the Tyne Iron Shipbuilding Company.

MR. F. JACKSON, member of the firm of Messrs. Spear & Jackson, steel manufacturers, Etna Works, Savile Street East, Sheffield, at the age of 46 years.

MR. F. T. MARSHALL, one of the directors of R. & W. Hawthorn, Leslie, & Company, Limited, in his thirty-ninth year. Deceased entered the works of the Company during 1883, and became managing-director in 1897.

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THE MASBOROUGH FOUNDRY COMPANY, of Rotherham, have disposed of their business to the Wigston Foundry Company, of Leicester, whither it is to be transferred.

NEGOTIATIONS are in progress between the Montrose Shipbuilding Company and the local Town Council for the acquisition of land for the erection of engineering works.

CORRESPONDENCE.

CASTING CORLISS CYLINDERS.

To the Editor of the FOUNDRY TRADE JOURNAL.

DEAR SIR,—Having two or three Corliss cylinders to make, I should like, if you would be good enough to allow me through the medium of your valuable journal, to ask if any of your readers would advise me how to "run" those castings so as to bring out the best "bore" possible with valves and barrel.

I am uncertain, and from what I read, some favour the horizontal position, some the vertical. Others cast flat, and again there are to be found men who favour none of those positions, but maintain that cylinders of all kinds should be cast "down hill," or "up hill." Such are the conflicting opinions to one having but little practice in this sort of work. The foregoing to a novice, is somewhat puzzling.

Now if some of your practical readers will give their experience on this subject much good may be done for those requiring information.

Permit me to add to this my appreciation of your reduced rate for the journal to workmen, which now puts it into their hands at a price below the charge of any other journal published dealing with the foundry trades exclusively. I am pleased to say that in the shop where I am engaged, through the reduction referred to, you have secured 15 per cent. of the journeymen employed, who hitherto subscribed to no technical journal.

But, after all, this is not great for the shop in question. It occurs to me that if only about one-half of this number were added to your readers from every foundry in the United Kingdom, exclusive of all others interested in the foundry trades, one would have hope that the day of awakening for moulders had at last begun. Surely this is not too much to expect. Six or more in every hundred interesting themselves in the problems of their trade. I am pleased to note that the new proprietors are giving encouragement to moulders and pattern-makers alike, by offering a monthly prize for the best illustrated description of work recently done. Hoping that the future of your journal will be one of unique success,

I remain, yours, etc.,

SUBSCRIBER.

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ROYCE, LIMITED, of Hulme, Manchester, have appointed Mr. J. G. Barber to represent them in the Birmingham district.

TRADE TALK.

MESSRS. A. RODGER & COMPANY, of Port Glasgow, have just started manufacturing a new gas engine.

MESSRS. C. H. TAYLOR & SON, of Leeds, are contemplating the erection of a new iron foundry at their works.

THE YORKSHIRE RAILWAY WAGON COMPANY, LIMITED, have acquired the business of the Nottingham Wagon Company.

SPERLING'S NUT-LOCK, LIMITED, of 19, Newgate Street, E.C., has been formed with a capital of £16,000 in £1 shares.

NEW furnaces have lately been re-started at Messrs. Flockton, Tompkin & Company's Newhall Steel Works, Sheffield.

THE STIRLING BOILER COMPANY are proposing shortly to introduce a new boiler, which will be called the "Meredith" boiler.

THE MOSS BAY HEMATITE STEEL COMPANY, LIMITED, have supplied a large quantity of steel rails to the East Indian Railway Company.

THE big mill at the South Durham Iron and Steel Company's Moor Works, Stockton, has been re-started after more than two years' idleness.

STAPLE LOCK-NUT COMPANY, LIMITED, has been formed with a capital of £1,500 in £1 shares, to carry on the business of nut manufacturers.

A DISASTROUS fire broke out recently at the Eglinton Iron Works, Kilwinning, Scotland, resulting in damage to the extent of about £5,000.

MESSRS. E. P. ALLAM & COMPANY, electrical engineers, have established new premises at 11, Red Lion Street, Clerkenwell Road, London, E.C.

THE LOWTHER IRON WORKS at Workington, have been purchased by Mr. T. W. Ward, of Sheffield, who, it is understood, will have them dismantled.

THE COURTS-TURNER ENGINEERING COMPANY, of Manchester, have acquired the business of the Smokeless Chimney Company, Limited, of Manchester.

MATTHEW REID & COMPANY, LIMITED, is the name of a company formed with a capital of £15,000 in £1 ordinary shares, to acquire the Kilmarnock Forge.

THE members of the firm of Messrs. Heaviside and Bontch, electrical and mechanical engineers, Newcastle-upon-Tyne, have dissolved partnership.

CHARLES CHURCHILL & COMPANY, LIMITED, have recently established a workshop at Pendleton, where all descriptions of machine tools will be turned out.

THE CLARENCE STEEL WORKS, Port Clarence, Middlesbrough, of Messrs. Bell Brothers, have lately been re-started after undergoing extensive alterations and improvements.

MESSRS. F. BERRY AND C. BERRY, engineers and tool makers, Sowerby Bridge, Yorkshire, trading under the style of Francis Berry & Sons, have dissolved partnership.

MESSRS. J. M. HENDERSON & COMPANY, of the King Street Engineering Works, Aberdeen, Scotland, have just established an office at 26, Victoria Street, Westminster, S.W.

A. & J. MAIN & COMPANY, LIMITED, of the Clydesdale Iron Works, Possilpark, Glasgow, have secured an order for steel palisading from the Egyptian Railway Administration.

THE VULCAN ENGINEERING COMPANY, WHITEHAVEN, LIMITED, was recently registered with a capital of £5,000, in £1 shares. The registered office is at 8, Albion Street, Whitehaven.

SLOAN & DAVIDSON, LIMITED, has been formed to acquire the engineering business at Stanningley and Leeds, of Sloan & Davidson. The capital of the concern is £25,000 in £10 shares.

BY an outbreak of fire recently at Messrs. John Crane & Company's marine engineering and shipbuilding yard at the Queen's Dock, Leith, a considerable amount of damage was done.

THE VICTORIA FOUNDRY AND ENGINEERING COMPANY, LIMITED, is the name of a company formed with a capital of £2,000 in £10 shares, to acquire the Victoria Foundry, Morriston, Swansea.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, have appointed as their representatives in India, Macbeth Brothers & Company, of Bombay, and Messrs. Heatly & Gresham, of Calcutta.

DOWELL SYNDICATE, LIMITED, has been registered with a capital of £500 in £1 shares, to carry on the business of manufacturers of and dealers in hydraulic, electric, and steam machinery and appliances, etc.

THE WALLACE STEEL WORKS, Sheffield, of Messrs. Blyde, Ledingham & Company, have recently been very much improved, by which the firm are now able to largely increase their output of crucible steel castings.

MR. C. H. PEARSON, lately connected with the London office of the Blaenavon Company, Limited, has been appointed the London representative of the Barrow Hematite Steel Company, Limited, for the sale of steel rails.

THE business carried on at Victoria Foundry, Bramley, Leeds, by Mr. F. Roberts, has been acquired by a new company, with a capital of £2,500 in £1 shares, which will trade under the style of Roberts, Brooks & Company, Limited.

THE partnership hitherto existing between Messrs. J. C. Hannah, W. Houston, and A. Smith, constructional engineers and smiths, Dudley Port, Staffordshire, who traded under the style of Hannah, Houston, & Smith, has been dissolved.

MR. ROBERT MCLAREN has joined the firm of Topping & Seavill, engineers, Rosario, and in future the firm will trade as Topping, Seavill, & McLaren, and as agents in the Argentine for Messrs. J. & H. McLaren, Midland Engine Works, of Leeds.

MESSRS. J. H. HACKWORTH & COMPANY, of 46, Queen Victoria Street, London, E.C., have been appointed sole agents for London and district for the sale of Mr. J. W. Chenhall's patent "Dartium Alloy," which is used in the manufacture of iron castings, etc.

THE business of Messrs. John Fraser & Son, of the Millwall Boiler Works, Millwall, E., has been turned into a limited liability concern, with a capital of £25,000 in £1 shares (12,500 preference). The firm will trade under the style of John Fraser & Son, Limited.

THE jubilee of the Manchester Steam Users' Association was celebrated during the month by a banquet, Mr. A. Dugdale, President of the Association, presiding. The Association, it will be remembered, was founded by Sir William Fairbairn, Mr. Henry Houldsworth, and Sir Joseph Whitworth.

FAIRBANK BREARLEY, LIMITED, has been registered to acquire the business carried on by G. N. Brearley, A. Brearley, J. Brearley, J. E. Brearley, and H. Brearley, at the Central Engine Works, Shipley, under the style of Fairbank Brearley. The capital is £6,000 in £1 shares (3,000 preference).

VERY extensive improvements are at present being carried out at the shipbuilding yards at Belfast of Messrs. Harland & Woolff, which are estimated to cost practically a quarter of a million sterling. The most important of these is the transmission of power to the firm's many machine tools.

THE assets and liabilities of the Machinery Users' Association have been purchased by the Machinery Users' Association (Incorporated), which was recently registered with 2,000 members, each liable for £1 in the event of winding up.

The office of the concern is at 5, Laurence Pountney Lane, E.C.

THE committee in charge of the arrangements for the reception of the Iron and Steel Institute in Sheffield are inviting subscriptions to a guarantee fund to meet the expenses of entertaining the visiting members. The committee desire to obtain a guarantee fund of about £5,000, of which £2,325 has already been promised.

THE BATMAN'S HILL IRON WORKS, and the Pyramid Iron Works, Bradley, the Britannia Iron Works, West Bromwich, the Britannia Iron Works, Bradley, the Regent Iron Works, and the New Regent Iron Works, Bilston, have all been acquired by Tupper & Company, Limited, a concern recently registered with a capital of £100,000 in £1 shares.

THE AVONSIDE ENGINE COMPANY'S new works at Bristol are now almost complete, so far as the buildings are concerned. A Mather & Platt 150-h.p. engine will be installed for driving the plant in the machine shop, with boilers by Messrs. Ruston, Proctor & Company. The shops will be equipped with overhead cranes for heavy work, and walking jib cranes for lighter purposes.

THE prospectus has been issued of R. Cundall & Sons (1905), Limited, a company formed, with a capital of £100,000 in shares and £27,000 in debentures, to acquire the old-established business of R. Cundall & Sons, Limited, Airedale Iron Works, Shipley, Yorkshire, and 20-22, St. Bride Street, London. The public were invited to subscribe for 35,000 preference shares and the whole of the debenture issue, bearing interest at 4½ per cent. per annum.

EXTENSIVE improvements have been carried out at the Canal Iron Works, Shipley, Yorkshire, of Messrs. J. Parkinson & Son. A new foundry, 200 ft. long by 40 ft. wide, was put in operation early in the year; its equipment is complete, and includes a 10-ton electric overhead travelling crane, with floor rails and truck, for the easy and rapid transportation of materials. Side buildings contain rooms for the preparation of sand, core-making, and core-drying ovens. An installation of pneumatic and other moulding machines enables small repetition work to be economically dealt with. The old foundry has been transformed into a heavy-tool machining and erecting shop. Here is also an electric overhead travelling crane, and smaller cranes to serve special machines. Considerable attention has been given to the lighting arrangements; abundance of well-distributed light being obtained.

PERSONAL.

THE late Sir Isaac Lowthian Bell, Bart., left estate of the gross value of £768,676, of which £674,317 is net personalty.

SIR W. H. HOULDSWORTH, Bart., M.P., has had the honorary freedom of the City of Manchester conferred upon him.

MR. D. WILLIAMS, of Llanelly, has been appointed a director of the Old Castle Iron and Tinplate Company, Limited.

THE gross value of the estate of the late Mr. F. Brightmore, a director of the Midland Iron Company, Limited, is £38,181.

MR. F. KENNERLEY PRESTON, A.M.Inst. C.E., A.M.I.E.E., has secured an important engineering appointment in South Africa.

MR. G. BEECH, of Birmingham, has been appointed a director of the Birmingham Railway Carriage and Wagon Company, Limited.

CAPTAIN H. ST. J. CRUICKSHANK, R.A., has been appointed Assistant Inspector of Steel at Sheffield under the Army Ordnance Department.

MR. J. DICK, manager of the Grangemouth branch of Messrs. W. Jacks & Company, has been appointed sales manager of the Skinningrove Iron Company, Limited.

MR. EDGAR ALLEN, of Edgar Allen & Company, Limited, Sheffield, has offered to contribute, on certain conditions, £10,000 to the funds of the local University.

MR. A. DEIGHTON, chief engineer at the Hallamshire Steel and File Works, Sheffield, has been appointed to a similar post at Messrs. Steel, Peech & Tozer's Steel Works, at Rotherham.

SIR RICHARD TANGYE, head of the firm of Tangye's, Limited, has been in New Zealand recruiting his health. He will spend some time in Australia, and will leave Melbourne on April 11 for England.

MR. G. H. STANLEY, the demonstrator in metallurgy and surveying at the Armstrong College, Newcastle-upon-Tyne, has been elected to the professorship of metallurgy in the Technical Institute, Johannesburg.

MR. J. BAKER, who has retired from the managership of the foundry department of Messrs. Bayliss, Jones & Bayliss, has been the recipient of an illuminated address, etc., subscribed for by the officials and men.

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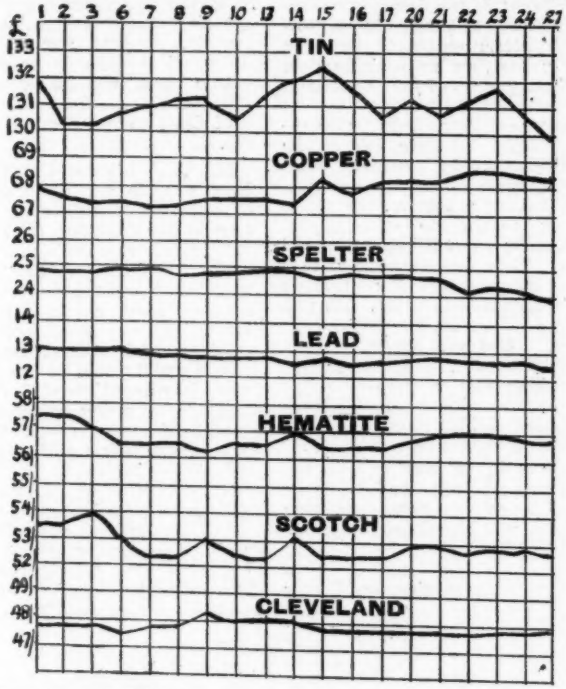
MESSRS. J. B. ROWCLIFFE AND F. ROWCLIFFE, who traded as the Atlas Engineering Company, at Levenshulme, near Manchester, have dissolved partnership.

CHART SHOWING THE FLUCTUATIONS OF THE METAL MARKET IN FEB., 1905.



PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1904-5.	1903-4.
Iron—Scotch pig warrant ... ton	53/1½	51/0
—Middlesbro' warrants ... ... ton	48 2	42/5
—W.C. M/nos Bessemer ... ... ton	58/3	54/0
—Stock, Scotch, Feb. 23. ...tons	14,260	8,600
Copper—Chili bars, GMB ... ... ton	£68 10/0—68 15/0	£57 7/6—£57 12/6
—Stock, Europe & afloat... ... tons	15,791	13,851
Tin—English ingots ton	£131 5—£133	£128 10—£129
—Straits ... ton	£131 7/6-131 17/6	£124 12 6-125 2/6
—Stock, Ldn. Hind and aflt ... tons	11,284	10,963
Lead—English pig ton	£12 13/9	£12—£12 5/0
Spelter—Ord. Silesian ... ... ton	£24 11/3	£22 2/6
Quicksilver-(75lb.) bottle	£7 12/6	£8 5
Antimony—Regulus ... ... ton	£37—£39	£29—£30

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 0 0	to	5 5 0
,, 3 to 4 in....	4 12 6	to	4 17 6
,, 5 to 8 in.	4 10 0	to	4 12 6
,, 10 to 16 in....	4 10 0	to	4 12 6
,, 18 to 24 in....	4 10 0	to	4 12 6
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 2 6

SCRAP.

The quotation for scrap subject to market fluctuations is as follows :—Engineers heavy scrap, 50s. to 52s. 6d.; ditto light scrap, 20s. to 22s. 6d.; clean scrap brass, 37s.; clean scrap copper, 59s.; lead (usual draft), 10s. 9d.; tea lead, 9s. 9d.; zinc, 18s.; hollow pewter, 95s.; black pewter, 60s. per cwt.

QUERIES.

This department of the JOURNAL *undertakes the answering of queries in foundry practice and pattern making. We trust our readers will afford us assistance in answering these queries so far as possible.*

THIN CASTINGS.—"Perplexed" writes:—I should be obliged for some help in the following difficulty:—In making some light iron castings about 6 in. diameter, 2½ in. deep, having a bottom, the whole casting being similar to a saucepan, minus the handle, the thickness of metal being $\frac{3}{32}$ in. They are invariably very hard, and as a great number of small holes have to be bored in them, this is a serious defect; otherwise, they are excellent castings. Can you suggest a soft mixture (Bestwood No. 1 is at present used), or, failing this, a simple method of annealing them, with a rough sketch of suitable oven? A hint as to any literature on annealing would be acceptable.

Mr. J. Howarth, of West Timperley, writes:—Perhaps I can assist "Perplexed" in his query regarding thin castings. Having experienced similar difficulties, I think they can be overcome without the expense of annealing by thoroughly drying all moulds, or, if only skin-dried, to cast them as soon as the mould is closed. I think he will find that it is the hygroscopic moisture the sand contains that is causing most of the trouble. A good soft mixture, which I have looked up, may answer the purpose better than the one he is using:—6 of Coltness No. 1 and 6 of Cleator No. 1; or, 6 of Coltness No. 1 and 6 of Glengarnock No. 1.

Mr. C. E. Allen, of Grantham, writes:—Your trouble arises, no doubt, from one or all the following causes:—1. Class of iron hardly suitable; (2) the castings are very much sand-chilled, through use of sand to damp; (3) though you do not mention it, the indiscreet use of hard scrap. Now, a No. 1 Gartsherrie is a much better class of iron for such light castings, and without scrap, Gartsherrie Nos. 1 and 3 would be a very soft mixture, used in proportion of 3 to 2. You will find the following suitable for softening your hard castings:—1st. 6 ozs. sulphuric acid, 4 ozs. nitric acid, 3 lbs. quicklime; put the mixture to 10 gallons of soft water, the castings to be put in red hot, and to be kept immersed in the mixture for 12 hours; 2nd, pack the castings into a sheet-iron box, amongst ordinary whiting, give them from three to four hours at a red heat, then allow the fire to die out.

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Bristol, October 25th, 1904.

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From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

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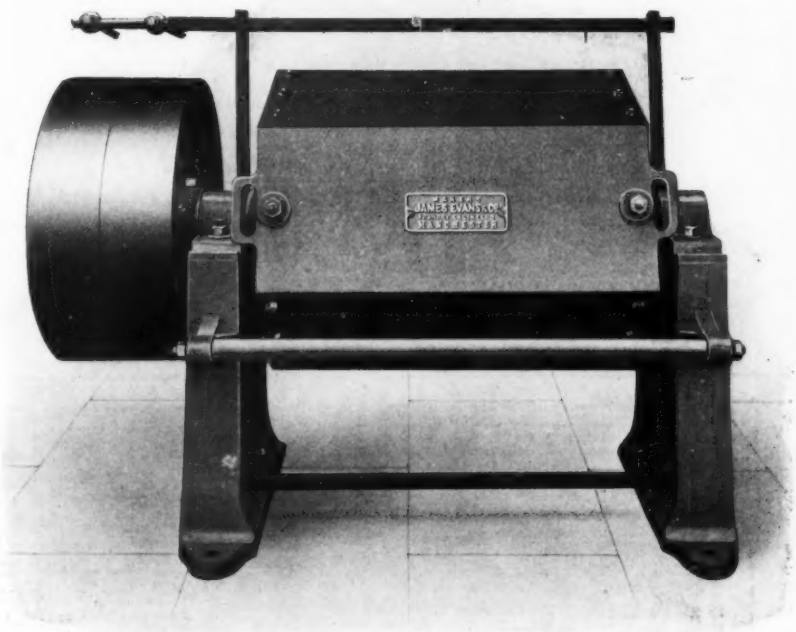

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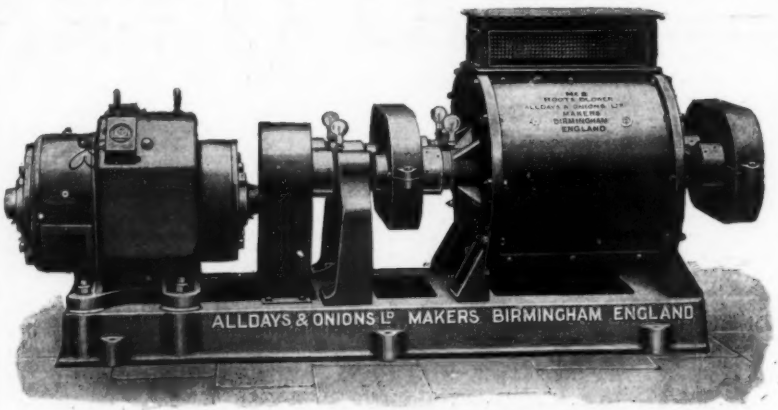

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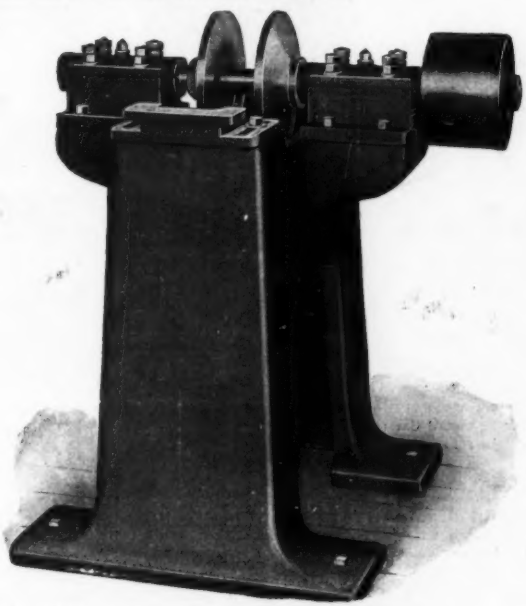

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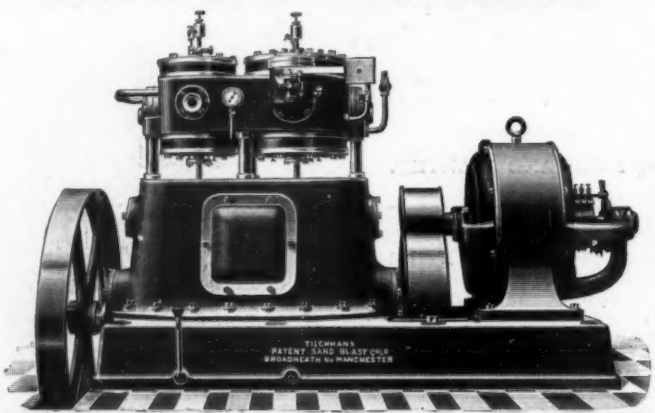

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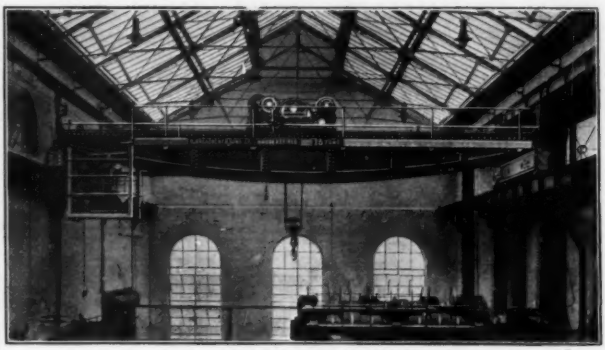

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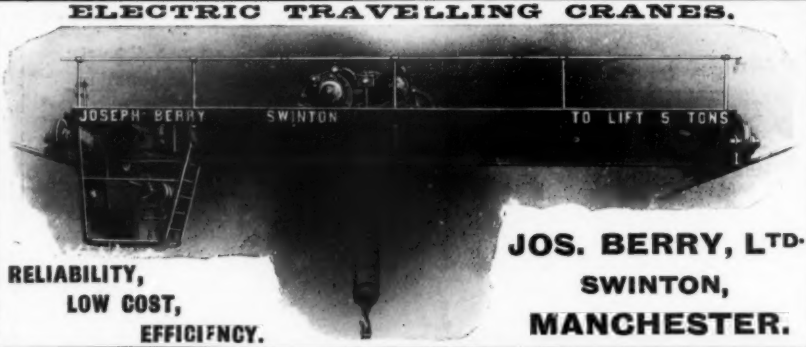

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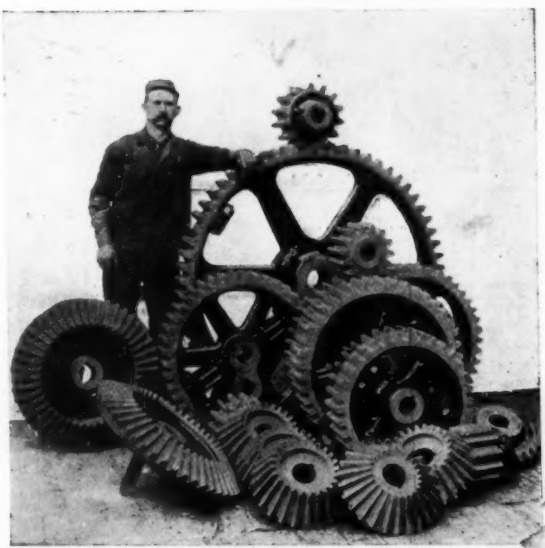

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